

Australia \$1.10 New Zealand \$1.20 Malaysia \$4.50

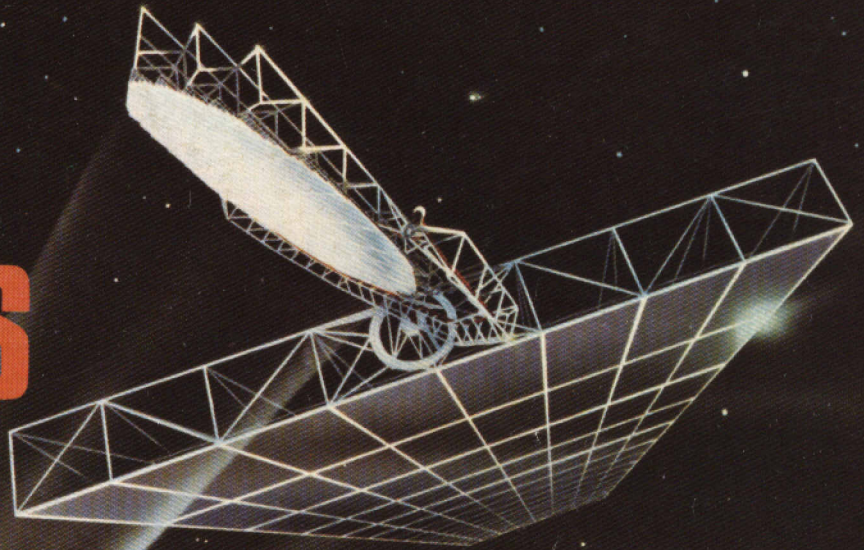
PRACTICAL

ELECTRONICS

JANUARY 1981

65p

SOLAR POWER SATELLITES



PE **STARSPINNER** PART 1

Also... **INTERFACING COMPUKIT** PART 1

PRACTICAL ELECTRONICS

VOLUME 17

No. 1

JANUARY 1981

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OUR FEBRUARY ISSUE WILL BE ON SALE FRIDAY, 9 JANUARY 1981
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REALISM

"WE ARE now, I believe, beginning to come to terms with the real world again. The myths are exploding and reality is breaking through."

So said Mr. John Nott, Secretary of State for Trade to the North West Branch of the Engineering Employers Federation in Bolton recently. A significant statement and one that we are sure is true in more ways than one! What worries us is that when its all over and the unemployment figures start to fall again will the inbred attitudes of industrialists and employees have changed significantly enough to have a real affect on our future? We live in a fast moving world and we must move with it, the electronics industry is good at doing this but we must introduce others to the advantages of robots and computers.

Take another quote if you will: "Today our profession is critically important to an effort that greatly concerns our nation—maintaining healthy technology through innovation. More people than ever understand that raising our standard of living to match our expectations largely depends on our ability to successfully advance our technologies."

"A growing concern is that we as a nation are losing our technological leadership and our traditional productivity advantage to others."

... "Our greatest single devotion must be to professionalism that in large measure requires technological currentness. On a wider scale, we need to renew ourselves in pursuing excellence in a world of change."

Mr. John Nott again, talking to the electronics engineer? No, wrong man and, believe it or not, the wrong country. That statement was made by William C. Hittinger, Executive Vice President, Research and Engineering for RCA.

Let us look more closely at this positive attitude which is perhaps what we in the UK lack. One thing that gives some insight into the feelings of America is the "growing concern that we as a nation are losing our technological leadership and our traditional productivity advantage to others." Few countries in the world would think in this way if they held the position of America in the electronics industry and for an RCA man to make the statement is even more significant.

There is also the realisation that "raising our standard of living to match

our expectations largely depends on our ability to successfully advance our technologies". We believe this to be something of an understatement but one which everyone should consider.

AMERICA AMERICA!

We are not all lovers of the American way of life or of Americans in general—they have a lot to answer for in respect of our nightly TV entertainment—but we cannot afford to ignore them and we should be prepared to copy the good. We see no reason why the UK cannot capitalize on the "reality that is breaking through", and start the tide that was the brain drain, flowing in the other direction, but it must come from us all, from a new approach, a new realism and a new need in everyone.

According to Mr. John Nott the signs are there and he went on to echo Mr. Hittinger's feelings by saying.

"We cannot enjoy a better life unless we provide the wherewithal by producing more goods and services more efficiently . . . The time has come again to look ahead."

The time has come for electronics!

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We regret that lengthy technical enquiries cannot be answered over the telephone (see below).

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Make Up/Copy Dept.: 01-261 6601

Technical Queries

We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in Practical Electronics.

All letters requiring a reply should be accompanied by a stamped, self addressed envelope and each letter should relate to one published project only.

Components are usually available from advertisers; where we anticipate supply difficulties a source will be suggested.

Back Numbers

Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 95p each including Inland/Overseas p&p.

Binders

Binders for PE are available from the same address as back numbers at £4.30 each to UK or overseas addresses, including

postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions

Copies of PE are available by post, inland or overseas, for £11.80 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perry Mount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

Market Place

Items mentioned are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

by
David Shortland

and
Jasper Scott

PROTECTED MULTIMETERS

Following their introduction of the quality Tester range of multimeters with modular construction and "Do-it-Yourself" repair facilities, Alcon Instruments Ltd have now introduced the SUPER 20 and SUPER 50 Testers from the same Miselco stable. These new instruments now include cut-out protection and semiconductor test facilities all provided in a package small enough to be called "pocket-sized" without exaggeration.

As their names imply, the two are similar in almost all aspects but have basic different movements offering sensitivities of 20k Ω /V and 50k Ω /V a.c. and d.c. respectively. Each instrument has 39 ranges covering from 100mV (150mV for the S/50) to 1kV d.c. and from 10V to 1kV a.c. Current ranges extend from 100 μ A to 10A (3A for the S/50) d.c., and 3mA to 10A (3A for the S/50) a.c. There resistance ranges, are five, covering from 5k Ω

to 5M Ω f.s.d. An optional high voltage probe extends the upper limit of the d.c. ranges to 30kV for TV and the like.

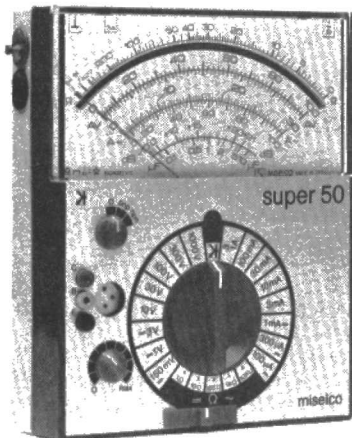
Accuracy figures are 2 per cent of f.s.d. for d.c., 3 per cent for a.c. and 1 per cent of centre scale for resistance. These values, coupled with the figures noted make the Super 20 an ideal general-purpose multimeter and the Super 50 well suited to specialist electronic measurement for which it was designed.

Both instruments are provided with fuse protection, a novel neon discharge system and a new electronic high-speed cut-out system. This latter serves to disconnect the instrument from external circuits should an overload voltage appear at the movement. The module is itself detachable from the circuit board, in line with the Tester practice, simply inserted on five pins. The cut-out operates when the applied energy exceeds that which the meter range identifies by a factor sufficient to prevent movement damage. This action releases the reset button to indicate activation.

The system is resettable manually by depression of a button and can be tested simply by pressing a "Test" black button to indicate battery and circuit state.

A simple semiconductor test facility is also provided capable of effecting basic function tests on most discrete devices swiftly and easily. In addition both instruments may optionally include a Universal Signal Injector capable of generating a signal rich in harmonics and detectable to 500MHz for radio and TV test purposes.

Prices for the two meters (complete with case, leads and instructions) are £56.81 and £59.00 including VAT. Alcon Instruments Ltd., 19 Mulberry Walk, London SW3 6DZ (01-352 1897).



JINGLE ALL THE WAY

Just in time for Christmas, the latest wrist job from Casio, their M12 melody alarm watch, has 12 memorised tunes (including Jingle Bells) as alarm signals.

In alarm mode, the M12 plays at the preset time each day a distinctive tune, changing according to the day of the week. With appropriate settings it plays "Happy Birthday", "Wedding Bells", or an alternative melody on suitable dates, and "Jingle Bells" as the Christmas Day alarm. For its twelfth trick, the M12 can sound hourly "Big Ben" chimes.



M12



M1200

A digital display shows time in hours, minutes and seconds plus am/pm (or 24 hour clock), with month, date and day available at the press of a button.

Also within the l.c.d. display is a five-line musical stave, on which "notes" appear as a melody is played. The M12 also has a countdown alarm/stopwatch function.

With resin case and strap, the Casio M12 is powered by a BR-2016 lithium battery with expected life of at least two years, and has a recommended retail price of £26.95.

Identical functions and characteristics are available in the superior packaging of stainless steel case and bracelet. This model is coded M1200, at RRP £34.95.

Casio Electronics Co. Ltd., 28 Scrutton Street, London EC2A 4TY.

SYSTEMA WEDGE

Systema Electronics have recently introduced a new style scientific calculator which should retail at around £13. Aimed directly at the volume end of the scientific calculator market, the Systema LC 34P offers comprehensive scientific operations including 3 level parentheses plus statistical functions.



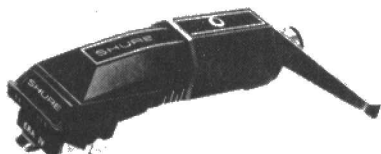
The wedge shaped design of the Systema LC 34P gives a perfect viewing angle on the students desk or engineers bench. The large liquid crystal display has an 8 digit capacity (or 5 digit mantissa and 2 digit exponent) plus operational symbols. Keyboard layout is clear and uncluttered with all dual functions colour coded.

This stylish scientific operates for about a year on 2 AA size penlight batteries which are easily available world wide. Supplied complete with soft carry pouch, the Systema LC 34P measures 144mm(L) x 75mm(W) x 18mm maximum (H) and should now be available from most good retailers.

INTEGRATED CARTRIDGE-HEADSHELL

Shure Electronics has announced the expansion of its line of M97 Era IV Series Cartridges with the M97HE-AH, a precision integrated cartridge-headshell with a universal four-pin bayonet headshell connector for instant installation in many leading turntables.

Shure claim that the integrated design of the M97HE-AH offers several advantages over separate cartridge and headshells, including easier installation, elimination of spurious resonances from insecure mountings, and a total weight reduction of 4-6 grams when compared to many other cartridge and separate headshell combinations.



As an added feature, the M97HE-AH is provided with a special pickup arm/cartridge alignment system which includes an overhang gauge and a non-operable alignment stylus. This allows precise overhang adjustment for minimum lateral tracking error without risk of damage to the actual playback stylus.

The M97HE-AH includes a nude-mounted hyperelliptical stylus, a viscous damped Dynamic Stabilizer, telescoped stylus, shank and the innovative Side-Guard—which protects against stylus damage frequently caused by sliding a cartridge across the surface of the record or by hitting the edge of the record. As a result, the M97HE-AH offers maximum stylus and record protection, as well as improved trackability in the critical mid and high frequencies at a tracking force of $\frac{1}{4}$ to $1\frac{1}{2}$ grams.

The recommended retail price for the M97HE-AH is £51.80 plus VAT.

Shure Electronics Ltd., Eccleston road, Maidstone, Kent ME15 6AU (0622 59881)

MINI TV

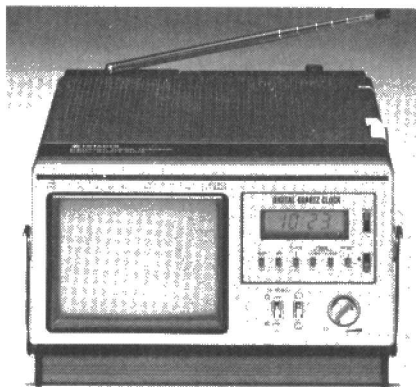
The latest TV from Hitachi is the K2300 model which is a 4 $\frac{1}{2}$ in. monochrome set with a digital clock. The unit works from a.c. mains, car battery, internal batteries or an optional battery pack.

The set works on either v.h.f. or u.h.f. frequency bands switched over at the touch of a button. Tuning has been simplified by using a vertical line on the screen which indicates the channel being received and is cancelled by a button once tuned in correctly.

The quartz digital clock can be set to switch the TV on or off at any pre-determined time which is ideal when you want to watch a programme in bed as there is no worry about falling asleep whilst watching and the set remaining on. The K2300 is fitted with an earphone socket for private listening and a recording jack for audio recordings onto a tape recorder.

The K2300 is finished in a silver and black cabinet and is provided with a carrying handle which can also be used as a stand for the set.

The price of the K2300 is £115 including VAT.



SCALED DOWN VIDEO

JVC are launching a new portable video system, the HR2200E. It incorporates highly advanced video technology in an ultra lightweight and compact form. Size and weight have been dramatically reduced while retaining full VHS compatibility.

The HR2200E weighs just 5.2kg and is constructed from R.R.P. — a new material which is both extremely light and strong. The chassis is moulded into a single unit and JVC have reduced the number of components by 50 per cent compared with their previous video recorders. A newly-developed high precision brushless quartz locked direct drive motor drives the head drum and transports the tape steadily while being carried.

The HR2200E is equipped with some superb facilities — a built-in microprocessor provides full logic control and solenoid operated pushbuttons mean that feather light touch is all that is required to change modes. For further convenience, the HR2200E comes complete with a remote control unit.

Other advanced features include variable speed playback, Edit Start Control, which automatically aligns separately recorded

SPEECH RECOGNITION SYSTEM

A speech input device for most popular microprocessors has been announced by William Stuart Systems Ltd.

Marketed under the name "Big Ears", the system consists of a microphone, pre-amplifier, analogue frequency filters and digital interface, complete with software.

Words are stored as voice patterns which the system learns from repetition by the user. Analysis is then by correlation over a statistical frequency plane which plots combinations of formants and harmonics throughout the speech waveform.

The unit has been designed to connect directly to the UK101/Superboard family of computers, or to any other via a spare user input port. The analysis programs are supplied in Basic language, with small real-time input routines written in 6502 or Z80 machine code.

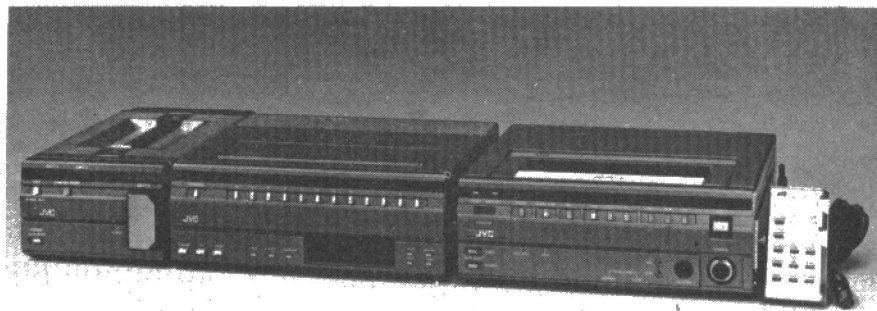
Typical uses for the system include data enquiry, robot control, computer games etc.,

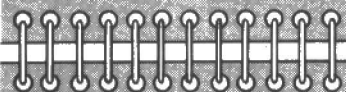
"Big Ears" is supplied fully assembled in a cabinet, and costs £45 plus VAT, including postage and packing. Please state which computer the unit is to be used with.

William Stuart Systems are at Dower House, Herongate, Brentwood, Essex, CM13 3SD. (0277 810244).

segments, avoiding distortion and a Shuttle Search facility — for the first time ever on a portable machine — which allows programmes to be reviewed in both forward and reverse directions at 10 times normal speed. A 3-way power supply gives the HR2200E added flexibility — it can be powered by household a.c. mains, car battery or by its own Nickel-Cadmium rechargeable battery pack which has over twice the life of lead acid batteries.

The HR2200E is complimented by the TU22E — a multi purpose unit which functions as a tuner/timer (with a 10 day preset capacity), a.c. power adapter and a battery charger. Together the HR2200E and the TU22E form a complete unit with no need for a separate a.c. power adapter or battery recharger. The TU22E can recharge the Nickel-Cadmium battery in just 90 minutes — this remarkable time-saving capability plus the long life of the Ni-Cad battery are yet two more important features that place the new JVC portable video system way above any other previous system. The AA P22E AC power adapter can also be used as a battery charger, and to supply power to the recorder if a tuner/timer is not being used.





INDUSTRY NOTEBOOK

By Nexus



Moral of the Metro

The almost universal chorus of praise which greeted the introduction of the BL Austin Mini Metro gave it a flying start in the market place. And, almost overnight, the public image of BL was transformed from a sick joke to a go-ahead organisation well able to compete in the cut-throat world of mass-production popular cars.

The explanation is simple. This was BL's first all-electronic car. Not the car itself but the dedicated application of electronic aids and techniques in research, development, testing and, above all, in production.

The Metro story is a superb practical example of the need for change and of its unhappy consequences. The highly automated production line is essential for achieving productivity and consistent quality. The product is better and cheaper. But automation reduces manpower and de-skills the work of those still retained on the production line. One BL worker on the Metro automated assembly track confessed to being even more bored than he was on the old manual track. Now, he complained, all he did all day long was to press buttons, a task which a child of ten could perform just as ably. He had become nothing more than a robot-minder.

Overall, however, there is just as much skill needed to produce the Metro as any other similar car. All that has happened is that the skill had been transferred away from the production line and into electronic hardware and software. Efficient, tireless, electronically programmed and controlled robots work round the clock. The line trouble-shooter is armed with a digital multimeter instead of a set of spanners. The semi-skilled assembler is down-graded to button-pushing, albeit with no loss of pay.

There is little choice in the matter. It may still be possible to almost hand-build a Rolls Royce limousine selling at £50,000 to an elite market. But for a mass market it is automate or die. It seems there is no escap-

ing the social consequences of automation apart from re-training, and we all know how hard it is to teach an old dog new tricks.

There is nothing new in all this. It has been happening steadily over the past 20 years. The Metro story is just the latest positive example of the increasing need to adapt to the reality of a fast-changing world.

Low Profile

The nationalised industries and services are deservedly unpopular. They are a burden to the taxpayer with their insatiable appetite for subsidies and create antagonism by their reluctance to improve performance.

The one really notable exception is Cable & Wireless Ltd, a consistent profit-maker, which few people even realise is 100 per cent owned by the British Government.

The company's policy is to keep a low profile on ownership, not through any feeling of embarrassment but out of political consideration. For Cable & Wireless operates world-wide with one of its principal activities being the planning, management and operation of overseas national communications services on a concessionary basis. The company has some 50 branch offices starting alphabetically with Abu Dhabi and Antigua and ending with Tonga, Tortola, Turks Island and Vanuato (New Hebrides).

The British Government, again for international political reasons, observes a hands-off policy with the company on its operations and only an arm's-length control on finances. To all intents and purposes C&W operates autonomously and with local loyalty to the countries it serves.

Of course C&W has the supreme advantage of being in a high-growth industry. But it is a tempting thought that the facts of operating almost entirely overseas in widely dispersed locations and with considerable freedom of action in technical and commercial decision-making has also contributed to success.

Stock Market

Present economic policies have thrown up many surprises and have amply demonstrated that so-called experts in economics are either duffers or that economic forecasting itself is anything but an exact science. About the only thing all the experts have been correct on is the easily predictable rise in unemployment, a continuation of the trend since 1974 under both Labour and Conservative policies.

The biggest surprise, considering universal groans on the high international value of the pound sterling, is the healthy overseas trade surplus. From a prediction of £2.75 billion in the red it now seems probable that the balance of trade over a 12-month period will at least be in the black, if not handsomely so.

Another surprise is the remarkable buoyancy of the stock exchange indices, indicating that despite all the gloomy talk there is considerable confidence in the future of British business and industry.

Punters in electronics shares buying and

selling at the right times should have done remarkably well. On the day it was announced that Britain had its highest ever recorded monthly balance of trade surplus I checked out some electronics share prices in terms of low and high price for 1980.

Here are some examples with low and high price in New Pence in brackets. Bulgin (22/38); Gray Electronics (30/76); Dubilier (31½/74); Electrocomponents (410/716); Electronic Machine (21/62); Farnell (218/378); Ferranti (254/490); GEC (325/538); Plessey (106/266); Racal (172/342); Rediffusion (65/104); STC (230/467); Thorn/EMI (262/378); Unitech (207/348).

With shrewd timing it was possible to more than double your money in a single deal. Arguably some of the shares are overpriced at their 'highs' but this merely reinforces the view that apart from oil and gold, well-managed electronics companies, with a long-term assured future, are the best bet in shares.

Writing of bets reminds me that at the recent Bookmakers Show 80 in London over a third of the exhibitors were showing electronic cash registers and calculators tailored to the bookies special needs in calculating and paying out complicated multiple bets like doubles and trebles and yankees. The bookies say they will be paying over £14 million to the Horserace Betting Levy Board this year, reflecting a 30 per cent increase in betting turnover, but whether in spite of or because of the recession is not clear.

UK Ahead

The struggle for international recognition of competing Viewdata services has resulted in a modest league table. The three contestants are France's Teltel, Canada's Telidon and Britain's Prestel. The scores in overseas sales at the time of going to press were France nil, Canada one and UK five.

Canada's only goal is Venezuela while the UK has already netted West Germany, Netherlands, Switzerland, Hong Kong and Austria.

Orders

Order books remain healthy. The TV fourth channel network generated a £5 million contract for microwave relay links for GEC and, still in the broadcasting field, Marconi booked a two million dollar US sale of VTRs. Racal-Decca has won a £4 million follow-on order for electronic warfare equipment for the Royal Danish Navy and MEL booked a £4 million contract for microwave landing systems for the Royal Navy. The first marine satellite earth terminal is to be constructed at Goonhilly under a £2.75 million contract with Marconi. UKADGE, a consortium of Marconi, Plessey and Hughes, has won the £100 million up-date contract for the UK Air Defence System which will be funded largely by NATO.

Meantime, exports are racing ahead with the aerospace industry with its large electronics content enjoying an all-time record year.

PE

Master Rhythm

Part 2

A.J. Boothman B.Sc.

ISTRUMENTATION for the *PE* Master Rhythm comprises twelve instruments on a single printed circuit board. The basic generators are five drum and four noise related circuits, plus a gain control circuit driven by the Accent pulse. In addition the Snare Drum and Rim Shot sounds are derived by combined use of the basic generators as required. The Low and High Tom-Toms double up to give Conga Drum and Low Bongo respectively, and the degree of resonance can be set as a compromise or biased towards either type of instrument.

DRUMS

The complete instrumentation circuitry is shown in Fig. 7. Four of the Drum circuits utilise the quad NAND gate IC10, whilst the fifth uses an inverter section of IC11. Taking the Bass Drum circuit as an example it consists of an oscillator based on IC10c, having a twin-T network with frequency determining components R45-47 and C9-11, damped out of oscillation by R48 in series with VR4. When the Bass Drum is required to sound a positive pulse appears at the input to R41, is shortened by C8, and appears across R45 to excite the circuit into oscillation at approximately 65Hz. The oscillation decays at a rate dependant on the position of VR4, and the signal level passed to the preamplifier is controlled by VR5.

EXTRA RESONANCE

As VR4, 6, 8, 10 and 12 are turned clockwise the length of the decay time increases and at some point uncontrolled oscillation will occur. The extra resonance obtained can be put to good use, particularly in the case of VR6 and VR8 where advancing the controls improves the Latin American instrumentation. VR12 has to be set in a compromise position balancing High Bongo against the Snare Drum sound.

CYMBALS

Transistors TR1 and TR2 gate a noise signal to produce the Cymbal sounds. The Short Cymbal envelope is generated through C38 with a decay length determined by C39 and R93/94 whilst the Long Cymbal envelope consists of the full control pulse width followed by a decay determined by C41 and R97/98. A tuned circuit, consisting of L1 and C48, filters the noise into a narrow band of frequencies to give a metallic effect.

BRUSHES

These are similar in operation to the Cymbal circuits and are based on TR3 and TR4. However, the tuned circuit is omitted to give a wider band of noise, particularly introducing increased low frequency noise.

HYBRID CIRCUITS

The Snare Drum effect is produced by triggering the High Bongo and Short Brush simultaneously through diodes D53 and D54, whilst the Rim Shot further incorporates the Claves through D49.

PREAMPLIFIER/ACCENT

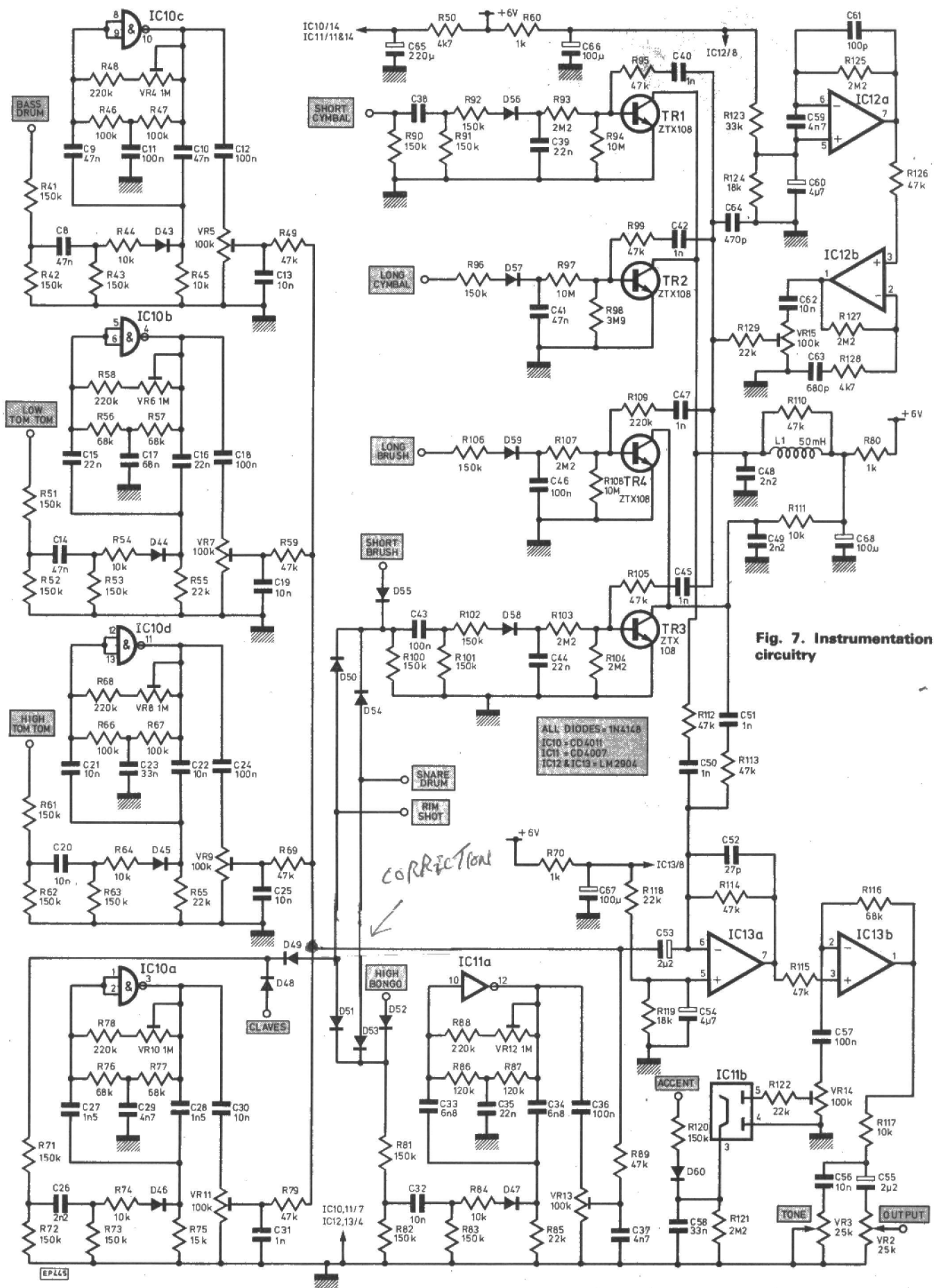
The preamplifier consists of a mixer, IC13a, followed by a voltage controlled output stage IC13b, the gain of which is increased above unity by the ratio of R116 to the resistance seen across VR14. The Accent is produced by switching the resistance across pins 4 and 5 of IC11b to a low state which places R122 across a portion of VR14 determined by its position, and consequently increases the feedback ratio and gain of IC13b. To carry out the switching operation the Accent control pulse is fed to the gate (pin 3) of IC11b through the envelope components R120, C58 and R121. Normally the f.e.t. which comprises IC11b is in a high impedance state and switches to low on receipt of the positive Accent pulse.

High frequency attenuation of the signal from IC13b is possible using the "Tone" control VR3. This allows compensation to be introduced for the frequency response of following amplifiers and in particular the avoidance of very high frequency distortion effects some times present. The Master Rhythm output level is controlled by VR2 which is combined with the supply switch S9.

INSTRUMENT BOARD ASSEMBLY

The track layout and component overlay details for the Instrument p.c.b. are given in Figs. 8 and 9. Whilst this board is less complicated than the Control Board careful assembly and inspection is again recommended. The suggested assembly order is pins, resistors, diodes, wire links, i.c. sockets, preset potentiometers, capacitors, transistors, and finally the Inductor.

When the Instrument board is complete, preset potentiometers VR4, 6, 8, 10 and 12 should be set fully anti-clockwise, giving minimum length of sustain, whilst VR5, 7, 9, 11, 13, 14 and 15 should be set to mid positions.



COMPONENTS . . .

INSTRUMENT BOARD

Resistors

R41-R43	150k (3 off)
R44	10k
R45	10k
R46, R47	100k (2 off)
R48	220k
R49	47k
R50	4k7
R51-R53	150k (3 off)
R54	10k
R55	22k
R56, R57	68k (2 off)
R58	220k
R59	47k
R60	1k
R61-R63	150k (3 off)
R64	10k
R65	22k
R66, R67	100k (2 off)
R68	220k
R69	47k
R70	1k
R71-R73	150k (3 off)
R74	10k
R75	15k
R76, R77	68k (2 off)
R78	220k
R79	47k
R80	1k
R81-R83	150k (3 off)
R84	10k
R85	22k
R86, R87	120k (2 off)
R88	220k
R89	47k
R90-R92	150k (3 off)
R93	2M2
R94	10M
R95	47k
R96	150k
R97	10M
R98	3M9
R99	47k
R100-R102	150k (3 off)
R103, R104	2M2 (2 off)
R105	47k
R106	150k
R107	2M2
R108	10M
R109	220k
R110	47k
R111	10k
R112, R113	47k (2 off)
R114	47k
R115	47k
R116	68k
R117	10k
R118	22k
R119	18k
R120	150k
R121	2M2
R122	22k
R123	33k
R124	18k
R125	2M2
R126	47k
R127	2M2
R128	4k7
R129	22k

All resistors 0.25W, 5% carbon film.

Capacitors

C8-C10	47n polyester
C11, C12	0.1µ polyester
C13	10n polyester
C14	47n polyester
C15, C16	22n polyester
C17	68n polyester
C18	0.1µ polyester
C19-C22	10n polyester
C23	33n polyester
C24	0.1µ polyester
C25	10n polyester
C26	2n2 ceramic plate
C27, C28	1n5 ceramic plate
C29	4n7 ceramic plate
C30	10n polyester
C31	1n0 ceramic plate
C32	10n polyester
C33, C34	6n8 polyester
C35	22n polyester
C36	0.1µ polyester
C37	4n7 ceramic plate
C38	47n polyester
C39	22n polyester
C40	1n ceramic plate
C41	47n polyester
C42	1n0 ceramic plate
C43	0.1µ polyester
C44	22n polyester
C45	1n ceramic plate
C46	0.1µ polyester
C47	1n ceramic plate
C48, C49	2n2 ceramic plate
C50, C51	1n ceramic plate
C52	27p ceramic plate
C53	2µ2/16V radial elect.
C54	4µ7/16V radial elect.
C55	2µ2/16V radial elect.
C56	10n polyester
C57	0.1µ polyester
C58	33n polyester
C59	4n7 ceramic plate

C60	4µ7/16V radial elect.
C61	100p ceramic plate
C62	10n polyester
C63	680p ceramic plate
C64	470p ceramic plate
C65	220µ/10V radial elect.
C66-C68	100µ/16V radial elect.

Semiconductors

D43-D60	1N4148 (17 off)
TR1-TR4	ZTX108 (4 off)
IC10	CD4011
IC11	CD4007
IC12-IC13	LM2904 (2 off)

Potentiometers

VR4, 6, 8, 10, 12	1M (5 off)
VR5, 7, 9, 11, 13, 14, 15	100k (7 off)

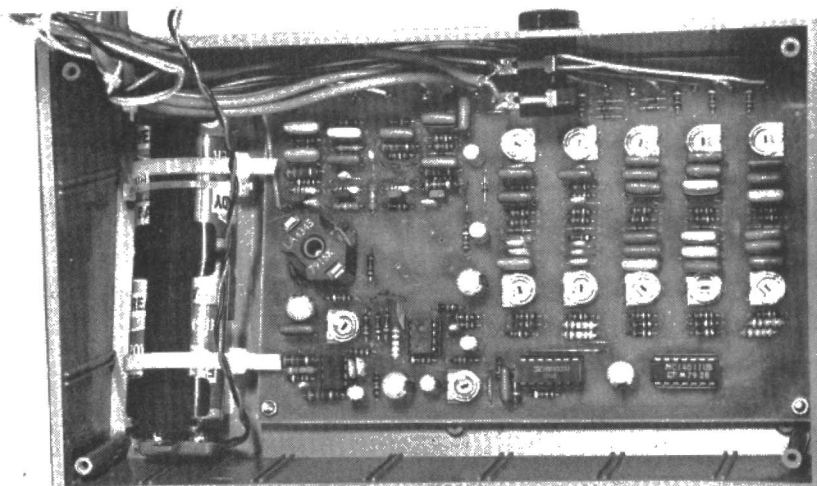
Inductor

L1	50mH
----	------

Miscellaneous

·040in. terminal pins (18 off)
 14 pin i.c. sockets (2 off)
 8 pin i.c. sockets (2 off)
 printed circuit board (1 off)
 box (minimum size 8½in. x 5in. x 2½in.)
 battery container (4 x HP7)
 ½in. 6BA clearance spacers (10)
 ¾in. 6BA screws (10)
 6BA full nuts (19)
 6BA insulated nut (1)
 colour coded wire (10/0.1)
 single core screened cable.

A complete kit can be obtained from
**Clef Products, 16 Mayfield Rd.,
 Bramhall, Cheshire SK7 1JU.**



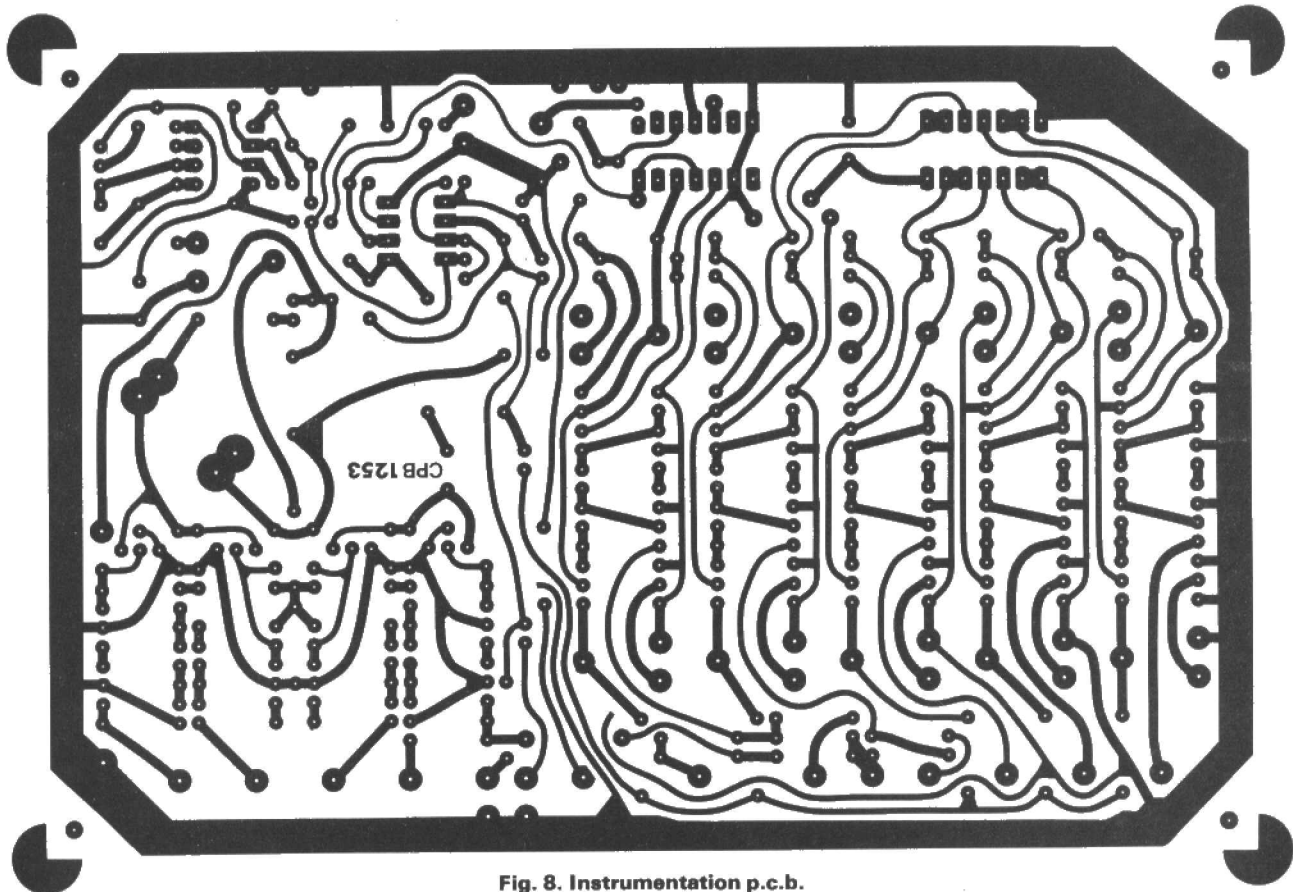
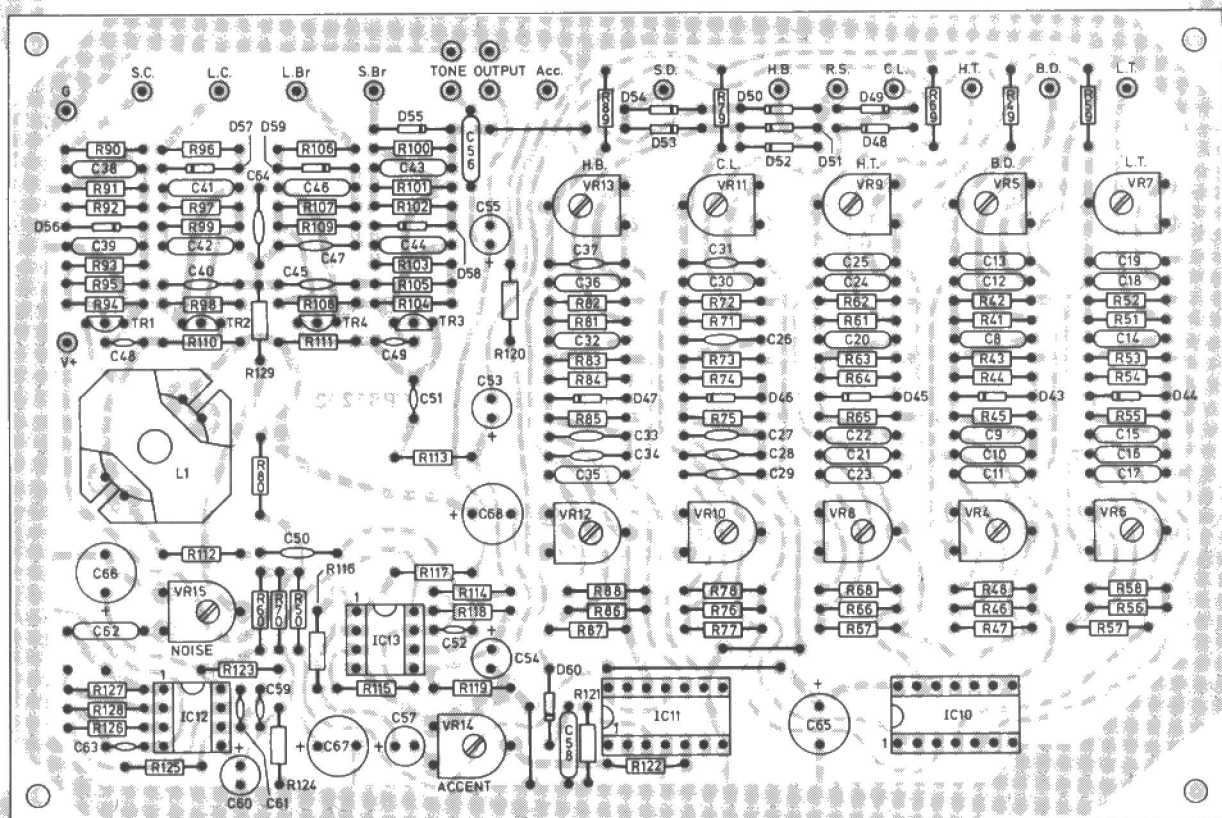


Fig. 8. Instrumentation p.c.b.



RHYTHM PATTERN EXAMPLES

1 WALTZ (A)

Acc.				
S.C.	X	X	X	X
L.C.				
S.Br.		X		X
L.Br.	X			
H.T.				
L.T.				
B.D.	X			

(B)

				X
X	X	X	X	X
		X	X	X
X				
X				X

2 QUICKSTEP (A)

Acc.				
S.C.		X		X
L.C.	X	X	X	X
S.Br.		X		X
L.Br.	X		X	
H.T.				
L.T.				
B.D.	X		X	

(B)

	X			
X	X			
	X			
X				
		X	X	X
		X	X	X
X		X		

3 BALLAD (A)

Acc.	X			
S.C.	X	X	X	X
L.C.				
S.Br.		X		X
L.Br.	X		X	
H.T.				
L.T.				
B.D.	X		X	

(B)

				X
X	X	X	X	X
	X		X	X
X		X		
X		X		

4 DISCO (A)

Acc.				
S.C.	X	X	X	X
L.C.	X	X	X	X
R.S.				
S.D.		X		X
H.T.				
L.T.	X		X	
B.D.	X		X	

(B)

				XXXX
X	X	X	X	X
	X			
				X
X			X	X
X		X	X	X

5 MARCH (A)

Acc.	X					X
S.C.	X			X		
L.C.						
R.S.						
S.D.	X	X	X	X	XX	X
H.T.						
L.T.						
B.D.	X		X		X	

TANGO (B)

X					XX
X		X		X	X
					XX
					X
X		X		X	

6 BOSSA-NOVA (A)

Acc.				
S.C.	XXXX	XXXX	XXXX	XXXX
L.C.				
C.L.	X	X	X	X
H.B.				
L.B.				
C.D.				
B.D.	X	X	X	X

BEGUINE (B)

XXXX	XXXX	XXXX	XXXX
X	X	X	X
X		X	X
X	X	X	X

7 CHA-CHA (A)

Acc.				
S.C.	XXXX	XXXX	XXXX	XXXX
L.C.				
C.L.	X	X	XX	XX
H.B.				
L.B.				
C.D.				
B.D.	X	X	X	X

SAMBA (B)

X			
XXXX	XXXX	XXXX	XXXX
XXXX		XX X	
	XXX		XXX
X	X	X	X

8 MAMBO (A)

Acc.				
S.C.	XXX	XXXX	XXXX	XXXX
L.C.	X	X	X	X
C.L.	X	X	X	X
H.B.		XX		XX
L.B.				
C.D.	X	X	X	X
B.D.	X	X	X	X

RHUMBA (B)

X				X
X	XX	X	X	X
X		X		X
	X	X	X	X
X		X	X	X
X	X	X	X	X

9 SLOW BEAT

(A)

Acc.				
S.C.	X	X	X	X
L.C.				
R.S.		X		X
S.D.		X	X	X
H.T.				
L.T.				
B.D.	X		X	X

(B)

X	X	X	X	X
		X		X
		X	X	X
X		X	X	

10 FAST BEAT

(A)

Acc.				
S.C.	XXXX	XXXX	XXXX	XXXX
L.C.				
R.S.				
S.D.	X	X	X	X
H.T.				
L.T.	X	X	X	X
B.D.	X	X	X	X

(B)

Acc.				
S.C.	XXXX	XXXX	XXXX	XXXX
L.C.				
R.S.				
S.D.	X	X	X	X
H.T.				
L.T.	X	X	X	X
B.D.	X	X	X	X

Acc.				
S.C.	X	X	XXXX	XXXX
L.C.	X		X	
R.S.		X		
S.D.		X	X	XX
H.T.				
L.T.				
B.D.	X	X	X	X

11 SWING I

(A)

Acc.	X	X		X
S.C.		X	X	X
L.C.	X		X	
S.Br.		X		X
L.Br.	X		X	
H.T.				
L.T.				
B.D.	X		X	

X	X		X
X	X	X	X
X		X	
X	X		X
X		X	
X		X	

(B)

Acc.		X		X
S.C.		X	X	X
L.C.	X		X	
S.Br.		X		X
L.Br.	X		X	
H.T.				
L.T.				
B.D.	X		X	

X	X		X
X	X	X	X
X		X	
X			
X			
X		X	XX

Fig. 10. Some suggested rhythm patterns

12 SWING II

(A)

Acc.	X	X		X
S.C.	X	X	X	X
L.C.	X		X	
S.Br.		X		X
L.Br.				
H.T.				
L.T.				
B.D.	X		X	

X	X		X
X	X	X	X
X		X	
	X		X
X		X	XX

(B)

Acc.		X		X
S.C.		X	X	XXX
L.C.	X		X	
S.Br.		X		X
L.Br.				
H.T.				
L.T.				
B.D.	X		X	

X	X		X
X	X	XX	X
X	X	X	X
X			XX

Key: Acc. ACCENT
S.C. SHORT CYMBAL
L.C. LONG CYMBAL
S.Br. SHORT BRUSH

L.Br. LONG BRUSH
H.T. HIGH TOM-TOM
L.T. LOW TOM-TOM
B.D. BASS DRUM

INTERWIRING

Twelve colour coded leads should first be soldered to the pins on the component side of the Control p.c.b. All leads should lie on the board such that they will exit at the side adjacent to the potentiometers. The use of 10/0.1 insulated wire is recommended for a neat finish, but care must be taken not to cut into the conductors when pairing back the insulation. The full interwiring details are given in Fig. 11, which shows a separation of approximately 3in. to allow for folding the Control board over the Instrument board and for the battery box to be positioned to the left of the Instrument board. Wiring can be completed with the boards in this position—i.e. Control board track and Instrument board components facing the constructor. Screened cable is required for the "Tone" and "Level" control connections.

MECHANICAL CONSTRUCTION

From various photographs given in the series it can be seen how the two p.c.b.s are mounted into the box with the Instrument board fixed to the base, and the Control board to the front panel.

The height of the three position slider switches above the Control p.c.b. is the determining factor for mounting the front panel, and this is matched using $\frac{1}{4}$ in. spacers with 6BA full nuts and screws at each of the mounting holes to give the correct distance. These may be tightened to the panel to allow the board to be removed without loosening the screws from the front, and the p.c.b. finally retained with a second set of nuts. It is important that the nut in the top centre position be of insulated type to avoid shorting to the p.c.b. track.

FINAL ASSEMBLY AND TEST

After completion of the interwiring and mechanics a few checks can be made before inserting any integrated circuits. The battery box polarity should always be observed carefully and on first connection C6 will charge to the full battery potential. With the power switch off the current drawn from the battery will slowly drop from around 20 μ A after initial charge to approximately 3 μ A. This effect is due to the forming of the capacitor during its early active life. The unit can then be turned to the on condition resulting in an increase in current to around 1mA. The current checks mentioned are

not essential but could help in detecting track shorts, accompanied by a considerable increase in supply current, which could be difficult to detect after insertion of the i.c.s. Voltage checks could also be made on the i.c. sockets, corresponding with the supply pins, and on the "Rhythm Select", "Sequence" and "Section" controls. By tracing through the circuitry many more tests could be devised but experience has shown that very careful physical inspection of the trackside of p.c.b.s, comparing against the track layouts in the series to detect shorts and particularly looking for unsoldered connections, is the secret to successful results.

When satisfied that all soldering is correct, disconnect the battery and discharge C6. The i.c.s should then be inserted into the sockets ensuring that orientation is carefully observed and taking normal CMOS precautions.

SETTING UP ADJUSTMENTS

Adjustments required are very few and it is suggested that the rhythm patterns given in Fig. 10 are first loaded into the Master Rhythm. Using the rhythms as a reference, the relative levels of all instruments may be adjusted using VR5, 7, 9, 11, 13, 14 and 15, and the envelope characteristics of the Drums can be adjusted using VR4, 6, 8, 10 and 12.



INTERWIRING DETAILS

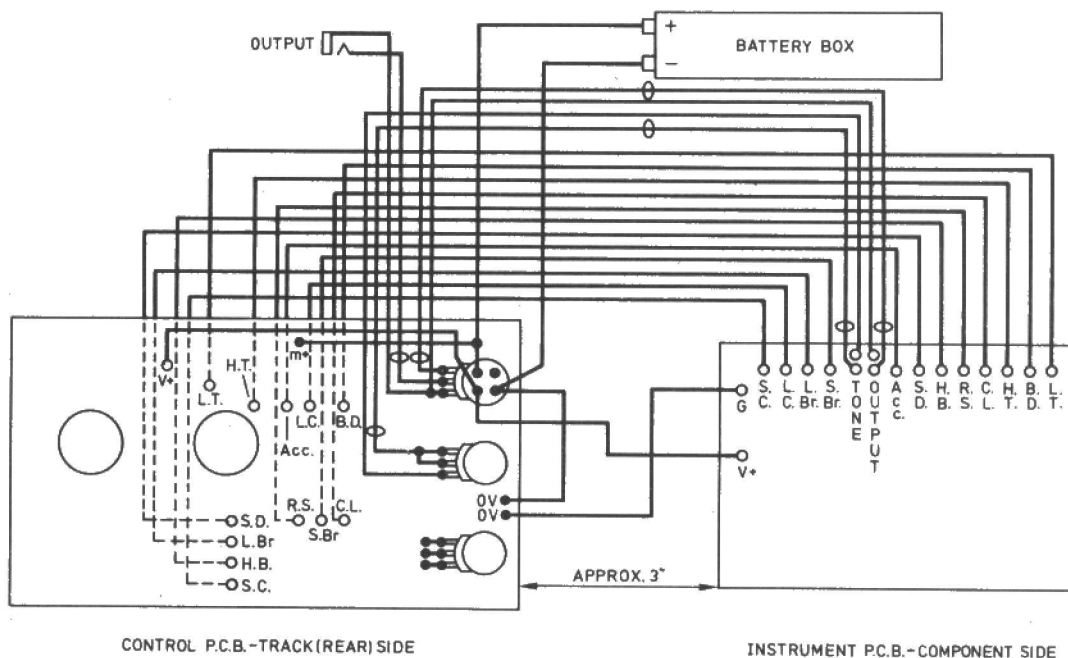
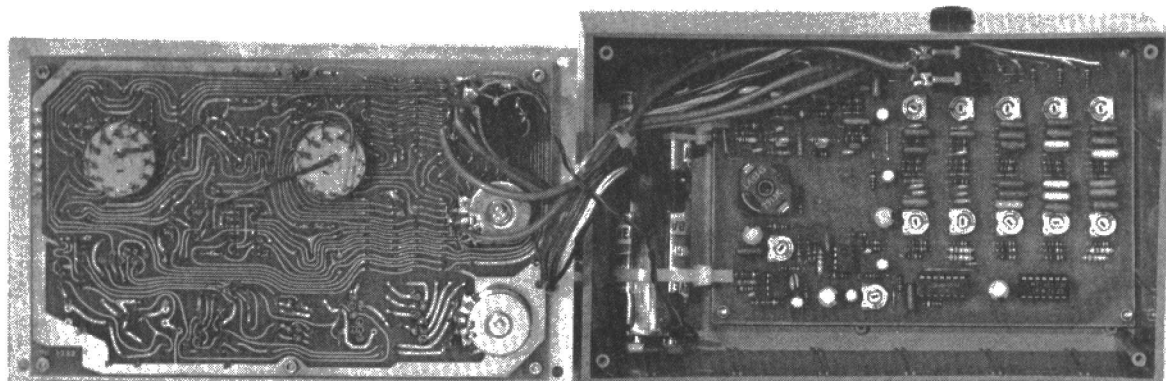


Fig. 11. Interwiring details



BOOK REVIEWS

ELECTRONICS EXPLAINED

by Peter Laurie

Published by Faber and Faber

132 pages, 190 x 245mm, Price £6.50 (loose leaf)

THIS book is subtitled 'A Handbook for the Layman' but unlike the handbook genre it makes no pretensions towards scholarship with the usual weighty appendages, chapter bibliographies and arid tortuous mathematical fleshing out. Amazingly it does pack into 129 pages introductions to audio, radio and digital electronics with an informal lucidity and an implicit anticipation in unravelling the more knotty areas for the newcomer to electronics. Much of this must stem from the author's avowed 'many years in pursuit of self education in these subjects' much of it practical.

The book is organised so that the reader is immediately drawn into audio topics and circuitry in Part 1 with modern semiconductor devices being used in the plentiful illustrations. For example these are 176 figures in the 50 pages that make up this section alone. Part 2 is devoted to radio and is a pithy read in the extent and application of modern communications. Part 3 on logic is a pretty well a text book approach on basics.

Part 4 is curiously placed in that it deals with fundamental concepts and the 'nuts and bolts' of electronics but since each part 'stands alone' there is no real reading order, but it would seem logical to bring this to the fore in a primer.

Part 1

PE STARSPINNER

PE STARSPINNER

THIS project describes a sophisticated lighting control unit known in discotheque circles as a 'zoning' or 'matrixing' unit. It is used with a display of up to 100 lamps which are normally arrayed in a star formation, comprising 10 bars each of ten lamps. The unit will produce a wide variety of sequential effects either in a circular motion (starspin) or in a radial motion (starburst). Either mode may be selected manually or the unit may be set to 'auto matrix' when the effect will change periodically from starspin to starburst and back again. The light display may also be set up as a rectangular formation with ten parallel rows of ten lamps. The matrix effect will then switch between horizontal and vertical scanning.

A total of 62 dynamic effects and 2 static effects are available and a sound to light facility is provided which will advance the sequential effects according to the beat of the music. Since the clock can be advanced a large number of steps in a very short time, certain sequences will appear to be reversed by the beat of the music. Along with the program selection which is controlled by six buttons, there is an automatic advance facility. This runs through the 32 basic programs in rotation, running each one four times. Some of them such as the 'fill and empty' routines described below occupy a program completely. Others, such as 'bar' effects are repeated four times in each run and are therefore repeated more times in the 'automatic' mode.

The unit described, and the printed circuit layout are for a total power handling of 6 kilowatts. This corresponds to four starburst displays made from 15W pigmy lamps, or one display using 60W spotlamps. It should be noted, however, that the basic design could be used for loads up to 2kW per channel if the power supply output devices, and printed circuit board were all uprated. Remember however that many of the programs are far more complicated than those on proprietary chaser units and allowances should be made for all lamps being on at once. If used in a mobile system with a standard 13A plugtop, the maximum load will be 3kW. This corresponds to two 15W pigmy lamp displays.

CIRCUIT DESCRIPTION

Although it provides a very impressive display the principle of the matrix unit is quite simple. A normal chaser has one side of

all the lamps commoned and the other side of the lamps are connected to the switched 'live' outputs. With the matrix/zoner unit both sides of the supply are able to be switched. There are (for a ten channel unit) twenty outputs instead of ten plus one common. The outputs are connected to circular and radial common lines in the case of the starburst display and to vertical and horizontal common lines where the display is rectangular (Fig. 1.1). Selection of a particular mode switches all the triacs which are connected to the live or neutral permanently 'on' whilst the other ten triacs are operated from the sequential circuitry.

The heart of the unit is a 2708 EPROM (IC6), pre-programmed with 31 sequences of 20 bytes plus a further 20 bytes which provide a static display. The section of the memory required is selected in the manual mode by a combination of 5 buttons (S2 to S6) which, via an OR gate for each button places a '1' directly on the address inputs A5 to A9. If the 'automatic' mode is selected, then the supply to these five buttons is removed and replaced with a zero potential, whilst a pair of 7493 (IC9) 4 bit counters connected in cascade are enabled. The two 7493's (IC9 and 10) address A5 to A9 via the other inputs of the two input OR gates (IC7 and 8). Outputs Q2 and Q3 from the first 7493 (IC9) and outputs Q0, Q1, and Q2 from the second 7493 are used, so that the automatic program advance takes place every 4 cycles of the main clock section. A sixth button is provided (S7) which inverts the signal to the last five channels (i.e. channels 6 to 10). This enables the unit to effectively double the number of programs available. It is also necessary to obtain certain effects. When selecting the automatic mode, the choice must be made whether or not to select button 6 manually and thus determine one of two groups of automatic programs.

A full list and description of the complete set of programs is given in Fig. 1.2 whilst Fig. 1.3 gives details of some of the more complicated routines available.

Note that some use button 6 and some do not. Because the 2708 is 8 bits wide and the unit was required to operate on ten channels, the sequential details are handled by five bits only. The other three bits are used to enable subsequent circuitry to direct the information as required. Outputs 1 to 5 of the EPROM contain actual information for the lamps. Output 8 enables channels 1 to 5 to receive information, output 7 enables channels 6 to 10

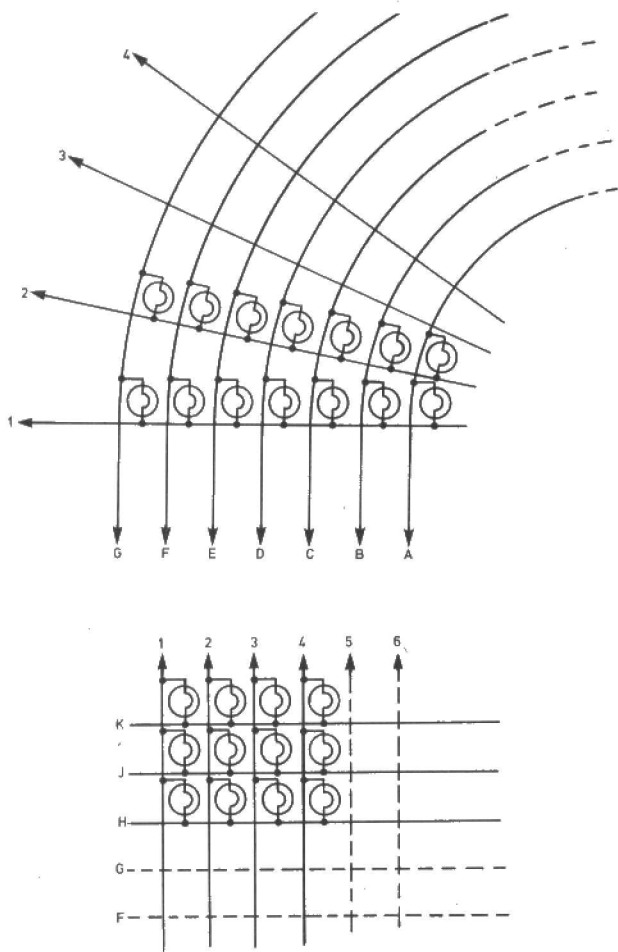


Fig. 1.1. Connection diagrams for starburst and rectangular displays.

1	2	3	4	5	6	
X						CHASE—single lamp chasing in one direction
	X					DOUBLE CHASE—two lamps chasing in one direction
		X				OSC CHASE—one lamp running forward and backward at irregular intervals
			X			PAIR CHASING—two lamps side by side chasing in one direction
				X		2 PAIRS CHASING—two sets of four lamps chasing in one direction
X	X					WHITEOUT—spaces chasing (ie dark lamps)—a bright display
X		X				PING PONG—single lamp running ten-ways forward and then reversing
			X			TWIN PING PONG—two lamps running backwards and forwards in opposite directions
X				X		CONVERGE—lamps light at the extremities of the display and move to the centre and repeat
X			X	X		OSC PAIR—as osc chase but with two lamps
		X	X	X		SKIP—chase pattern which runs through two or three lamps, jumps and continues
X	X	X		X		TRACER—lamps run 1,3,5,7,9,2,4,6,8, 10 etc
						PENDULUM—A chase but with the

		X	X				speed increasing at the centre of the display so that the lamp appears to be operating in a simple harmonic mode
		X		X			BAR—a group of lamps moving across the display continuously
			X	X			PING PONG BAR—a group moving backwards and forwards from side to side
							JUMPING BAR—a group of lamps moving in leaps across the display
X		X			X		OSC BAR—as previous osc effects but with a group of lamps
X	X	X					FILL-EMPTY—display fills towards centre and empties from the outside
X	X		X				BURST—DISPLAY FILLS FROM CENTRE AND EMPTIES slowly back again
X	X				X		SWELL—as burst but with a smooth motion
X			X	X			FILLOUT—display fills from the centre, extinguishes and repeats
		X	X	X			SLOW FILL—lamps run from outside to centre, stop and this repeats until the display is full—extinguishes and repeats.
		X	X		X		LEFT-RIGHT FILL—LAMPS light in order 5,4,3,2,1, extinguish then 6,7, 8,9,10, and extinguish
		X			X	X	HARLEQUIN—1 lamp chases 1 to 5 whilst a dark lamp chases 6 to 10 pattern then reverses and repeats
			X	X	X		STROBING—lamps 1,2,3,4,5 light four times, then 6,7,8,9,10 four times
				X	X	X	FLIP FLOP—lamps 1,3,5,7,9, illuminate simultaneously then 2,4,6,8,10
X		X	X	X	X		RANDOM—a number of lamps light, are replaced by apparently unsequenced others and so forth
X	X			X	X		RANDOM FILL—first one and two lamps light at random, then the number of on lamps increase until the display is full
	X	X	X	X	X		ALL FLASH—no explanation needed
	X	X	X	X	X	X	HAZARD—lamps 1,2,3,4,5 then 6,7,8, 9,10 light simultaneously and alternately
X	X	X	X	X	X		ALL LAMPS ON

Fig. 1.2. Complete program set.

MEMORY OUTPUTS									MEMORY OUTPUTS								
	1	2	3	4	5	6	7	8		1	2	3	4	5	6	7	8
0	1	0	0	0	0	1	0	1	0	1	1	1	1	1	0	1	1
	0	1	0	0	0	1	0	1		0	1	1	1	1	0	1	1
	0	0	1	0	0	1	0	1		0	0	1	1	1	0	1	1
	0	0	0	1	0	1	0	1		0	0	0	1	1	0	1	1
	0	0	0	0	1	1	0	1		0	0	0	0	1	0	1	1
5	0	0	0	0	1	1	0	1	5	0	0	0	0	0	0	1	1
	1	1	0	0	1	1	0	1		1	0	0	0	0	0	1	1
	0	1	0	0	1	1	0	1		1	1	0	0	0	0	1	1
	0	0	1	0	1	1	0	1		1	1	1	0	0	0	1	1
	0	0	0	1	1	1	0	1		1	1	1	1	0	0	1	1
10	0	0	0	1	1	1	0	1	10	1	1	1	1	1	0	1	1
	1	0	0	1	1	1	0	1		0	1	1	1	1	0	1	1
	0	1	0	1	1	1	0	1		0	0	1	1	1	0	1	1
	0	0	1	1	1	1	0	1		0	0	0	1	1	0	1	1
	0	0	1	1	1	1	0	1		0	0	0	0	1	0	1	1
15	1	0	1	1	1	1	0	1	15	0	0	0	0	0	0	1	1
	0	1	1	1	1	1	0	1		1	0	0	0	0	0	1	1
	0	1	1	1	1	1	0	1		1	1	0	0	0	0	1	1
	1	1	1	1	1	1	0	1		1	1	1	0	0	0	1	1
	0	0	0	0	0	1	0	1		1	1	1	1	0	0	1	1
SLOW FILL									BAR—USE BUTTON 6								

SLOW FILL

BAR—USE BUTTON 6

Fig. 1.3. Listing of memory outputs.

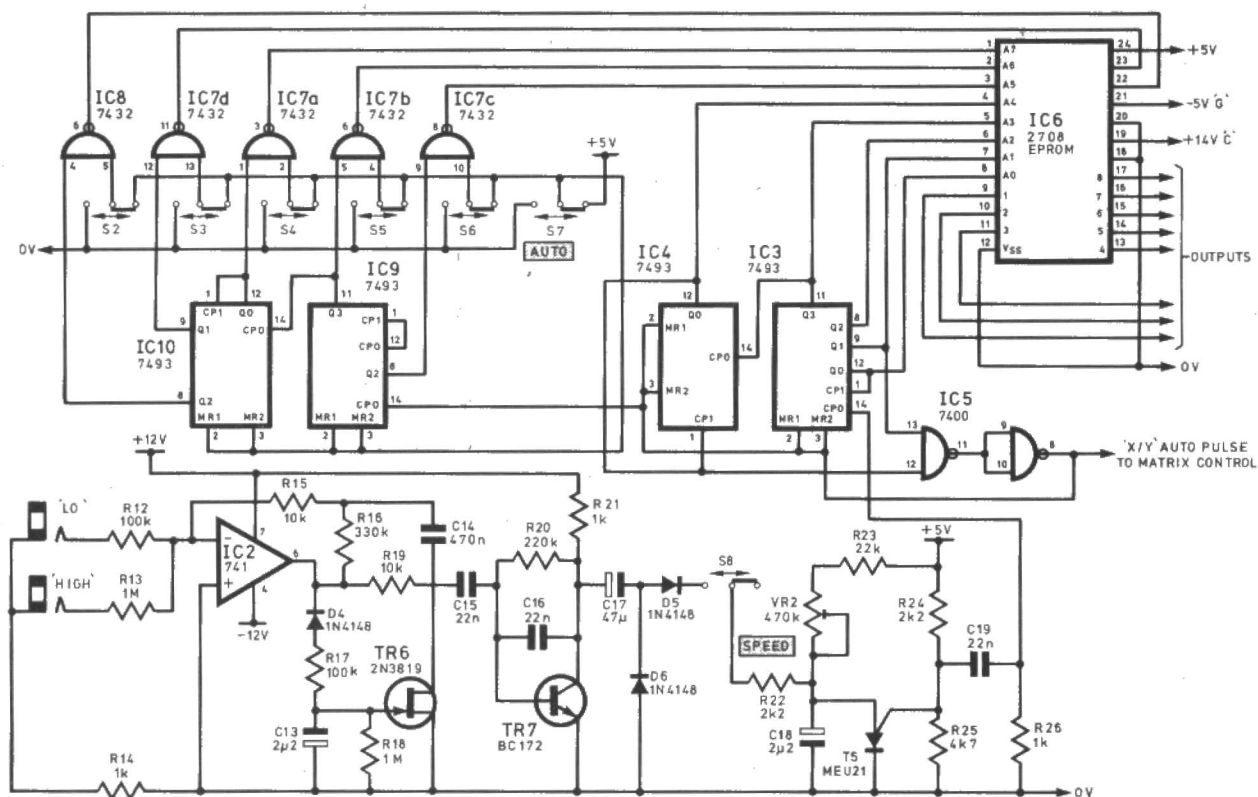


Fig. 1.4. Memory circuit and counter section.

COMPONENTS...

Resistors

R1	220 1W
R2, R3, R8, R11	470 (4 off)
R4, R27-R57	270 (32 off)
R5, R14, R21, R26, R118, R119	1k (6 off)
R6, R9, R25, R122	4k7 (4 off)
R7, R10	22k (2 off)
R12, R17	100k (2 off)
R13, R18	1M (2 off)
R15, R19	10k (2 off)
R16	330k
R20	220k
R22, R24	2k2 (2 off)
R23	22k
R58-R77	180 (20 off)
R78-R97	22 (20 off)
R98-R117	100 (20 off)
R120, R121	82 (2 off)

All resistors 1W 5% carbon except where otherwise stated.

Potentiometers

VR1, VR2	470k lin. preset (2 off)
----------	--------------------------

Capacitors

C1, C2, C7, C8	330µ 16V elect (4 off)
C3	1000µ 10V elect
C4, C5, C6, C12	100n (4 off)
C9, C10, C17	47µ 16V elect (3 off)
C11	47n
C13, C18	2µ2 10V tant (2 off)
C14	470n ceramic

C15, C16, C19

22n
C20-C39 47n (20 off)

Semiconductors

D1	1N4001
D2	4V7 400mV Zener
D3, D27-D36	Red l.e.d. 0.2 in (11 off)
D4-D6, D7-D26	1N4148 (23 off)
REC1-REC4	WO1 (4 off)
TR1-TR3, TR7, TR8 TR9	BC172 (6 off)
TR4	ME 8002
TR5	MEU 21
TR6	2N3819
CSR1-CSR20	TXAL226B (20 off)
IC1	LM309
IC2	741
IC3, IC4, IC9, IC10	7493 (4 off)
IC5, IC13, IC14, IC15, IC16	7400 (5 off)
IC6	2708 EPROM
IC7, IC8	7432 (2 off)
IC11, IC12	7486 (2 off)
IC17-IC36	SOC72 darlington opto-isolator (20 off)
IC37	7473

Miscellaneous

Push button switches d.p.c.o. 6mm spacing	(11 off)
Jack socket (p.c.b. type) mono	(2 off)
Mains transformer	
Fuseholders 20mm p.c.b. type	(21 off)
FS1-FS10 20mm 3A fuse	(10 off)
FS11 10mm 1A fuse	
L1-L20 3A choke	(20 off)

Constructor's Note

A complete kit of parts or individual components can be obtained from Feltglow Ltd., 105B London Road, Bexhill, East Sussex (0424 221686).

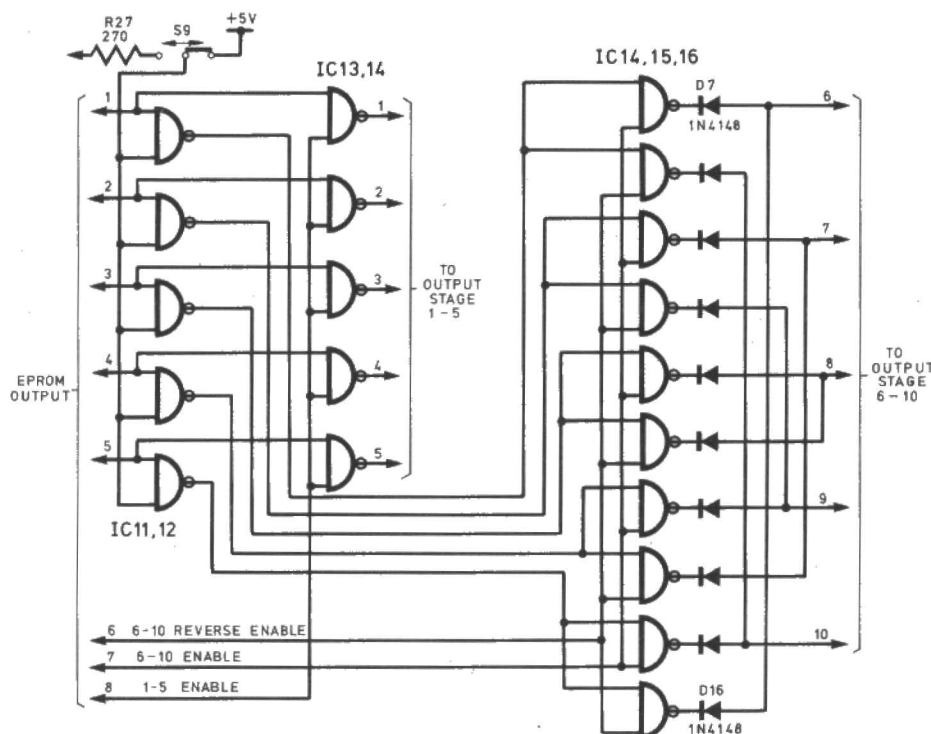


Fig. 1.5. Output signals from the EPROM.

to receive information and output 6 also enables channels 6 to 10 but in reverse order. Only the first 20 bytes of each group of 32 are utilised and the main clock resets after each count of 20.

CLOCK AND AUDIO TRIGGER

The memory circuit and the counter section is shown in Fig. 1.4. This consists of a programmable uni-junction transistor (TR5) which oscillates at between 0.5Hz and 5Hz. All four outputs of IC3 are used to address the EPROM at A0 to A3 whilst the Q0 output of IC4 addresses A4. The Q0 output of IC4 and the Q1 output of IC3 are fed to a 2 input NAND gate (IC5) and then inverted and fed back to the master reset pins on the two counters. This reset pulse is also used to clock IC3 in the automatic program section described above. A feed is also taken to the automatic matrix/zone selection.

If the automatic program button is depressed, all the selection buttons 1 to 5 receive zero volts in either position. The master reset terminals of the auto section counter (IC9 and 10) are switched to 0V and the counter is then free to operate. It is triggered from the reset pulse of the main counter and therefore clocks once every full cycle of the program playing at that time. When set to automatic this will initially be the basic chase having address 00000, i.e. no buttons depressed, since the automatic counter has been 'waiting' in the reset mode. When the program has run through four times a '1' will appear at the Q2 terminal of IC9, addressing the memory via the OR gate. Each of the main addresses will be selected in this way, running through a total of 32 separate programs. Button 6 may be left in or out giving a grand total of 64 separate programs, although the automatic program mode is intended for use with button 6 not operated, since it applies to only a few of the catalogued effects. The clock is also triggered by the output of the audio section. There are two audio inputs, covering a signal range of 200mV up to 50 volts input. Both are high impedance. These inputs feed a 741 op-amp which is used as a compressor in conjunction with a 2N3819 f.e.t. The output of the 741 is rectified

and used to bias the f.e.t. As the output of the 741 increases, the bias on the f.e.t. becomes increasingly negative and the f.e.t. tends to have less effect in shunting the feedback path comprising 330k and 10k. The 470nF capacitor (C14) ensures that this shunt effect takes place with a.c. only thus making the circuit stable as far as d.c. conditions are concerned. The output of the 741 is also fed to a 'booster' stage which provides heavy bass emphasis. The output is rectified and then fed, via the sound to light switch, to the clock oscillator.

SIGNAL ROUTING

The routing of the EPROM output signals is shown in Fig. 1.5. Only five outputs of the memory contain information to operate the lamps. These five outputs are fed to:

- (a) Five (2 input) NAND gates (IC/13 and 14). The other inputs of these five gates are commoned together and taken to output 8. When both inputs of a gate receive a '1' the output of the gate becomes '0' thus operating the two opto-isolators and channel indicator I.e.d.
- (b) Five exclusive OR gates (IC/11 and 12). The other inputs of these two input gates are commoned and taken to button 6 which when operated will place a '1' on the commoned inputs. The exclusive OR gates will then invert any signal arriving at the other inputs. The output of each gate is fed to two 2 input NAND gates (IC/14, 15, and 16). The spare inputs of each pair are commoned up to their counterparts on the other four channels providing two commoned lines which then connect to outputs 6 and 7 on the EPROM. The outputs of the NAND gates are wired to the opto-isolators in pairs, using blocking diodes, the second set of 5 being wired in reverse order.

NEXT MONTH: Output stage, power supply, phase control, construction and testing.



LINEAR OHMMETER

D.H.E. KING

THIS ohmmeter has been designed around the LM3914 display driver i.c. and has six ranges with a 10 l.e.d. display.

A basic ohmmeter consists of a 1.5V cell, a zero-setting resistor and a milliammeter as shown in Fig. 1. As R_x is varied so the current varies but not in proportion this means that the scale calibration is non-linear. However if a constant current is

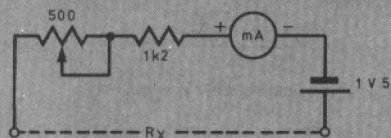


Fig. 1. Basic series-type ohmmeter circuit.

fed through R as in Fig. 2 then the voltage developed across it would be directly proportional to the value of resistance and a voltmeter across R can be scaled in ohms instead of volts. The LM3914 i.c. has a voltmeter function with an l.e.d. readout and has the characteristic of only demanding a 50nA input current. The i.c. can via pin 9 give "dot" or "bar" readings; a moving dot has been chosen for this application.

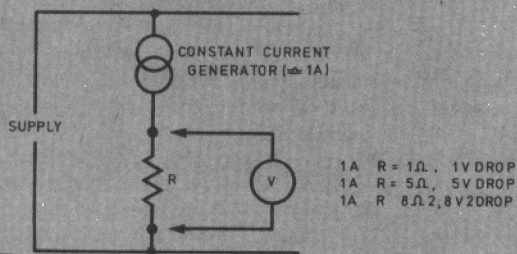


Fig. 2. The constant current generator enables the voltmeter to be scaled in ohms.

A constant current generator in its simplest form is shown in Fig. 3. The base voltage is defined by the Zener diode, the base-emitter volt-drop is fairly constant for a silicon device at 0.6V, so a given value for the emitter current (I_e) is set and constant, providing that the volt-drop across the load does not exceed a sensible value. For Fig. 3 values, $V_b = 2V$, $V_e = 1.4V$ and if the emitter current is required to be 10mA then $I_e = 1.4V/10mA =$

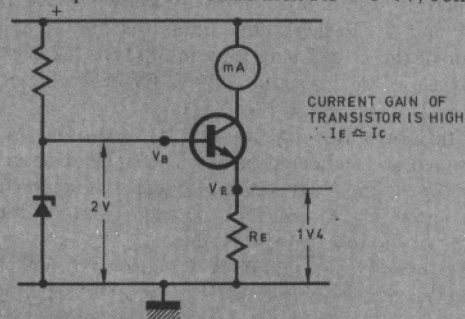


Fig. 3. A basic constant current generator circuit.

140Ω. There are a number of assumptions made here and in the absence of standard 140Ω resistors it would be preferable to have a constant but pre-set base voltage available. By using a resistor larger or smaller than the value as calculated the constant current will be proportionally decreased or increased (but do not forget the transistor ratings $I_{c \max}$ and $P_{c \max}$).

CIRCUIT DESCRIPTION

The LM3914 has a stabilised voltage of about 1.25V available at pin 7 and a part of this voltage applied to pin 6 (with pin 4 connected to zero) defines the full-scale voltage sensitivity. In the circuit diagram (Fig. 4) two full-scale values are selected by means of $S1b$, 0.3V and 0.9V. The constant 1.25V is also applied to TR1 base and thus $R2$ defines the collector current of TR1 as $I_c = (1.25 - 0.6)/47 = 14mA$ approx. This is maintained constant despite any drop in battery voltage and the constant volt-drop across $D15$ provides a constant voltage drive to TR2

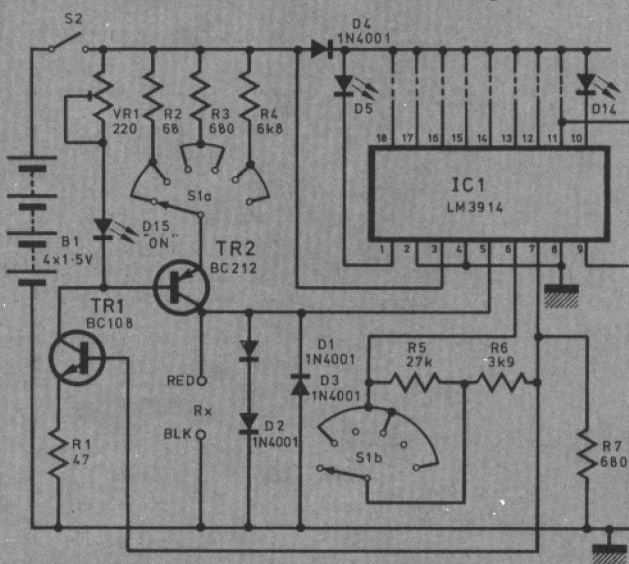


Fig. 4. Complete circuit diagram of the Ohmmeter.

base as well as giving an "on" indication. When the voltage drops to 3V the brilliance of D15 reduces considerably and informs that battery replacement is necessary. TR2 is the second constant current generator, having currents of 30, 3, 0.3mA selected by R2, R3, R4; with these standard values fitted, a pre-setting of TR2 base voltage is available by use of VR1 since the p.d. across D15 is not accurately known, being between about 1.6V and 2.5V depending upon the size, manufacturer and colour of the l.e.d. Using a basic 68Ω for R2 it is assumed that TR2 base voltage is set to about 2.6V below the positive rail, i.e. $IC2 = (2.6 - 0.6)/68 = 30mA$.

With 30mA flowing through 1 to 10 ohm resistor a p.d. is developed and indicated on the 0 to 0.3V scale in ten equal 1Ω steps. By changing the range of the voltmeter circuit to 0.9V (short-circuiting R6 via S1b) the same 30mA through 0 to 30Ω is indicated in ten steps of 3Ω each. If "Rx" in Fig. 4 were open-circuit then D1 and D2 allow the current to flow and drive D14 indicating a full- or over-scale. If inductors are tested and opposite polarity back-e.m.f.s generated, D3 takes over from D1-2 in the other direction and limits any reverse voltage to 0.6V.

RANGE VARIATIONS

Variations to the circuit design are quite simple; six ranges are not essential, S1 may be omitted and a single emitter resistor fitted for TR2. Six ranges in a 1:10 ratio might be considered, allowing for measurements from 1Ω up to 1MΩ; attention should then be paid to the values of resistors since the high-range constant current of 0.3μA is getting near to circuit leakage values! A "low" range of 0 to 1Ω would need a battery to supply the constant 300mA (HP7s are quite suitable for this) but TR2 would need to be uprated to a BD132, the collector power dissipation of TR2 would be some 1.5W. It is not really feasible to consider a 9V battery supply since the anodes of D5

COMPONENTS . . .

Resistors

R1	47
R2	68
R3, R7	680 (2 off)
R4	6k8
R5	27k
R6	3k9

All resistors 0.25W 5% carbon

Potentiometers

VR1	220 min. hor. preset
-----	----------------------

Semiconductors

D1-D4	1N4001 (4 off)
D5-D14	l.e.d. TIL 209 (10 off)
TR1	BC108
TR2	BC212
IC1	LM3914

Switches

S1	2 pole 6-way rotary switch
S2	s.p.s.t. switch

Miscellaneous

Battery holder and connector
HP7 battery (4 off)
Terminals red and black
Holder for i.c.
Case.

to D14 are ideally fed from no greater than 5V and a more complex voltage regulator would be needed. The brightness of the l.e.d.s may be varied by means of R7, at present about 20mA flows through a selected l.e.d.; a value of 1kΩ reduces the current to about 10mA while a value of 390Ω increases the current to nearer 30mA. (In fact R7 has a similar function for IC1 as has R3 for TR1 or R4 for TR2 in defining the value of the constant current for the illuminated l.e.d.s.)

The p.c.b. design for the ohmmeter is shown in Fig. 5 with the component layout shown in Fig. 6. The switch S2 can be replaced by an on-off slider or toggle type rather than with a spring-loaded type. The suggested layout and panel markings

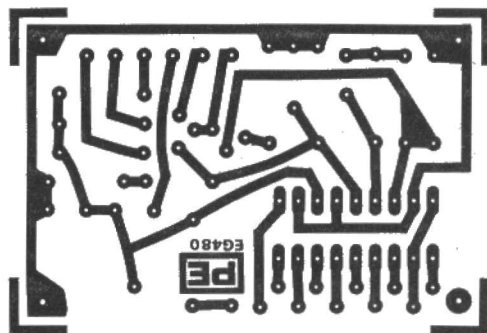


Fig. 5. Design for the Ohmmeter p.c.b.

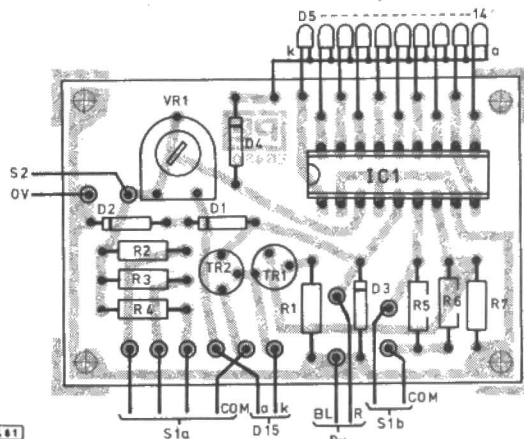


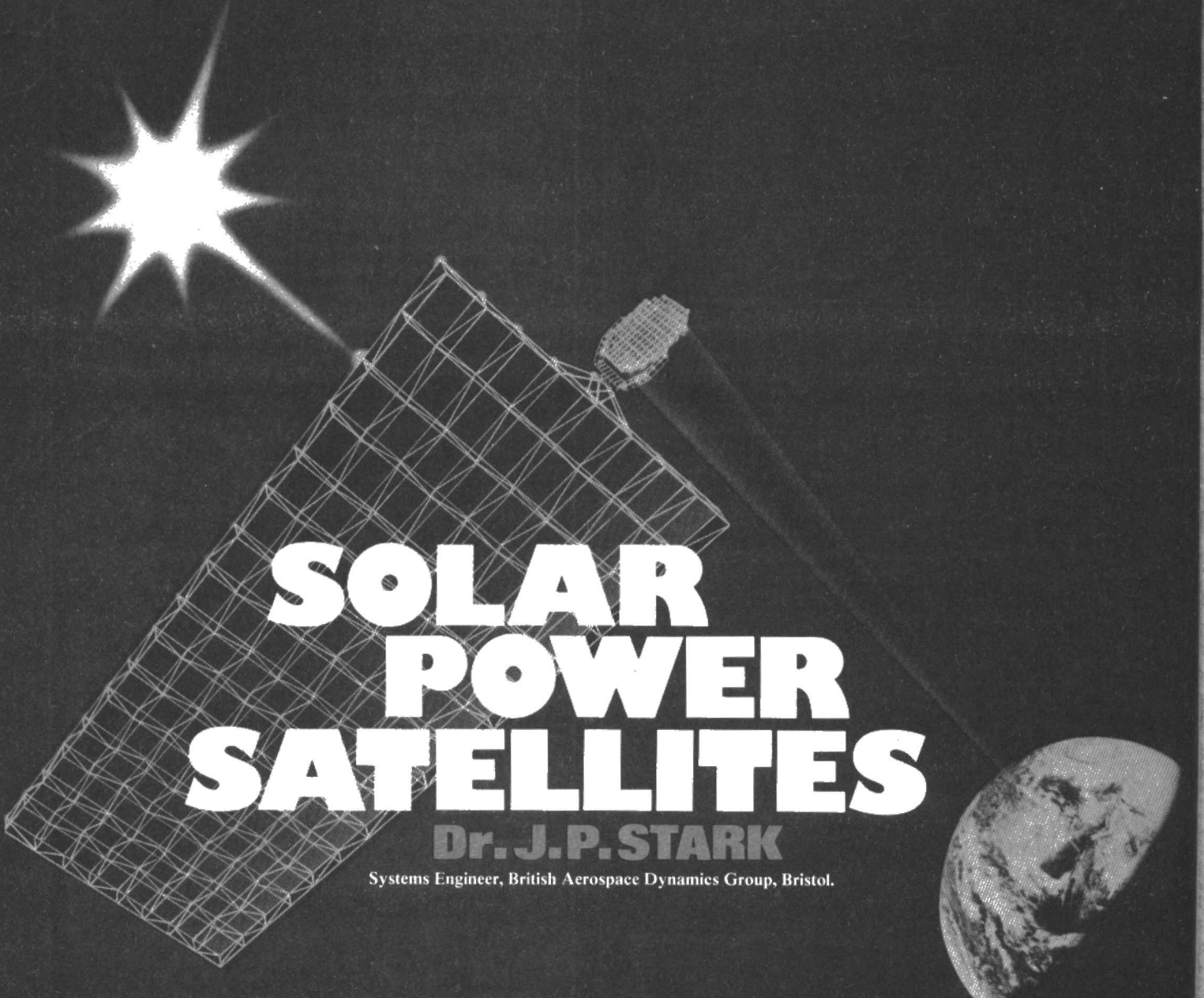
Fig. 6. Component layout and wiring.

allow for the unit to be held and switched on by the left hand whilst using the probes with the right hand, all l.e.d.s and markings being visible at the same time.

SETTING UP

Only one range of the instrument need to be calibrated using either a milliammeter or an accurate resistor. Set S1 as shown in Fig. 4 and vary VR1 to pass $30 \pm 1mA$ via a milliammeter connected across the test terminals. Or, connect a known 5Ω resistance (two 10Ω in parallel) across the test terminals and adjust VR1 to be in mid position between just lighting D9 and D11, i.e. indicating "centrally" on D10. The resulting settings will hold true for all other ranges to within the accuracy of the instrument, i.e. $\pm \frac{1}{2}$ a step, dependent upon the range.

Using the 30/300/3000 ranges the known 0.9V full-scale sensitivity allows for identification of diodes: a full or over-scale indication results for reverse-polarity tests (i.e. high resistance) while a 0.6V forward volt-drop indicates a silicon device and about 0.1 to 0.2V clearly suggests a germanium device. The battery voltage should be above 4V; the LM3914 will operate with down to 3V but the 4V limit is due to the minimum requirements of 0.9V across "Rx" plus 2V across R4 to R5 plus 1V needed for TR2 Vce operation. ★



SOLAR POWER SATELLITES

Dr. J.P. STARK

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THE "Energy Debate" is now, after the growing publicity of recent years, a subject of which we are all aware. The crux of the energy problem is that the earth's resource of fossil fuels is being depleted at an ever increasing rate as a result of existing international energy policies. The appreciation of this problem has led to an evaluation of hitherto unexplored energy routes, many utilising the inexhaustible (as far as concerns us on this planet) supply of energy from the sun.

One such route, which has been under active consideration principally in the U.S., is via the solar power satellite (SPS). This system collects solar radiant energy, 36,000km above the surface of the earth (in a geostationary orbit (GEO)), converts this energy to a form suitable for transmission to a ground receiving site where it is coupled into an existing electrical grid network.

Below, the energy situation particular to the UK is outlined. This information is presented so that the usefulness to the UK, of alternative methods of electricity generation, may be identified. The SPS system itself is subsequently described. Finally, the usefulness and applicability to UK of such a system is defined.

UK ENERGY CONSUMPTION

Figures provided by the department of energy for primary energy consumption in the UK for last year (1979) indicate that

an equivalent of 354 million tons of coal (mtce) were used. Of this, approximately 23 per cent was consumed in the generation of electricity. Table 1 indicates the detailed breakdown. It should be noted that 1 mtce is equivalent to the energy derived from 0.6 million tons of oil or would be consumed in the generation of 20×10^9 kW hours of electricity; it is also equivalent to 1 billion (10^9) therms.

Table 1. Primary UK Energy Consumption (1979)

Petroleum	34.8%
Gas	27.4%
Electricity	22.6%
Solid Fuel	15.2%
Total	354mtce

SPS generates electrical power only and thus has the potential for altering our present fuel dependence in this area.

Table 2 indicates the fuel usage for electrical energy generation. It is evident that we are heavily dependant upon coal and oil, with only 1.5 per cent of our electrical power generated from any non-depletable source; in the UK this is hydro-electricity. Considering the information of Table 2 with that of Table 1, one can derive information relating to our dependence on different

Table 2. Power Station Fuelling

Coal	72.9%
Oil	14.9%
Nuclear	10.2%
Hydro	1.5%
Gas	0.5%
Total	280 × 10 ⁹ kW hr.

fuels for our overall energy requirements. This is shown in Table 3. This indicates that our dependence on fossil fuels is in excess of 95 per cent of our total energy requirement. One method of reducing this dependence is to alter the ways in which we generate electricity. Adoption of such a policy would have the potential of reducing our fossil fuel dependence by 20 per cent. This is obviously a significant reduction, however, on its own, it does not solve the energy crisis. This fact must be remembered for any energy system which, fundamentally, only generates electrical energy.

Table 3. UK Energy Dependence

Petroleum	39.3%
Coal	36.4%
Gas	19.7%
Nuclear	3.5%
Hydro	0.5%
Other	0.6%

This energy crisis is derived from the world's usage of fuels which are not being replaced. In order to establish the time scale for exhaustion of these fuels it is essential to gain some knowledge of present estimated fuel reserves, present rate of usage and projections for future usage.

The only one of these figures which is known to any accuracy is the present rate of usage. Future projections are highly dependent upon overall world growth rates and the extent to which the third world participates in industrial expansion. Estimates for the fuel reserves, both for the world and the UK, are given in Table 4. The reserves are shown in terms of their energy equivalent relative to coal.

Table 4. Depletable Fuel Reserves Estimates

Fuel	World (mtce)	UK (mtce)
Solid fuel	10 ⁶	5 × 10 ⁴
Oil	3 × 10 ⁵	6 × 10 ³
Gas	2 × 10 ⁵	2 × 10 ³
Oil Shales	4 × 10 ⁵	8.3 × 10 ² — 3.3 × 10 ³
Uranium	4 Mteu	4 × 10 ⁴
		(Assuming breeders)

This table shows that the UK has considerable resources of coal. These deposits represent 5 per cent of the estimated world reserve. In Britain this is the only significant energy reserve. The world figure indicated for uranium is given in terms of tons of uranium, and is the estimate for economic recovery of Uranium Oxide. The economic extraction cost is estimated to be £25/lb, which is just over twice the present market price. Highly speculative estimates based on geological interferences suggest about three times this level, but the cost of recovery could make such reserves unattainable.

The reserve of uranium indicated for the UK, 4 × 10⁴ mtce, is the amount of energy which could be derived from the stock-pile of suitable material held in establishments such as Windscale, if fast breeder reactors are commissioned. It must be emphasised that breeders do not produce a limitless supply of energy, they

do, however, use fuel some 50 to 100 times more efficiently than the present generation of thermal reactors such as the Pressure Water, Magnox and Advance Gas Cooled reactors.

DEPLETION RATES

Consideration of energy growth rates in isolation from socio-economic and socio-political factors can not, with any great accuracy, indicate when our depletable fuel reserves will be exhausted. There is most certainly a relationship between gross national product and energy demand, however, the difficulty of economic forecasting alone is evidenced by the plethora of contradictory projections provided by various independent bodies. Thus, whilst acknowledging the limitations of such an analysis, Table 5 provides details for world depletion of fossil fuels for varying energy growth rates. It should be noted that for the years 78/79 the UK total energy demand increased by 4.2 per cent, however, the usage of coal and gas each increased by 7 per cent. It is clear that as certain fuels become exhausted more rapidly than others, the strain on the remaining fuels will become more severe.

Considering the total world fossil fuel usage at present, and if one assumes a 4 per cent per annum growth rate in usage, then all fossil fuel reserves will be exhausted in less than 50 years. This is clearly very worrying.

Table 5. Timescales for Depletion Fossil Fuels

Growth (Annual)	Current Total Reserves (years)	Solid Fuel (years)	Oil (years)	Gas (years)
0%	139	379	82	155
2%	67	108	49	72
4%	48	71	37	51

The depletion rate of fuel used in nuclear reactors is more difficult to identify, due to the varying technologies employed for electrical power generation by this means. If reactors of the fast breeder type are never employed on a commercial scale, then the reasonably assured reserve of 4 million tons, assuming a growth rate in demand of only 2 per cent, will be exhausted in less than 30 years according to figures published by the Energy Technology Support Unit (ETSU). In fact the average increase in the usage of nuclear fuel over the last five years was twice this in the UK.

If one considers the world growth rate then the situation is considerably more perplexing; for the period 76/77 a growth rate of nearly 18 per cent occurred. One way to reduce the demand for uranium is to introduce breeder reactors. These reactors can effectively utilise the most abundant isotopes of uranium, namely U238, rather than only U235 used in the present generation of nuclear reactors. However, breeder reactors rely, in the first instance, upon plutonium generated by thermal reactors before they can become independent of the U235 supply. Work published by ETSU indicates that even if fast reactors are introduced on a large scale by the year 2010, requiring orders for them to be placed by the year 2000, then the economically accessible Uranium will already have been exhausted. However, the total requirement for uranium over the next 100 years should be kept below 8 million tons, which although not being economic to extract, probably does exist.

In summary, there will be (unless world demand for energy falls dramatically) serious shortfalls in energy availability by the turn of the century. Fig. 1 indicates how this gap will continue to grow in the future.

This shortfall is entirely resultant from our almost total dependence on fossil fuels. Fossil fuels are no more than stored

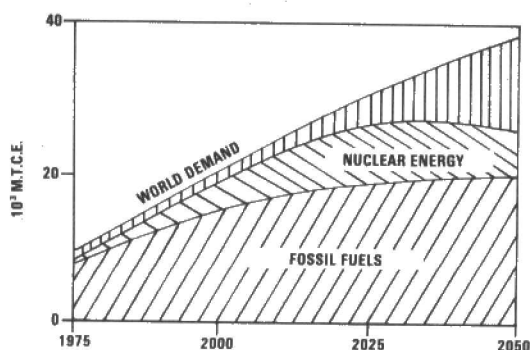


Fig. 1. The growing energy gap assuming a low (2%) growth in energy demand.

solar energy, the process of accumulation, however, takes millions of years. However, the solar radiant energy incident upon our planetary atmosphere is occurring at a continuous rate in excess of 10^{14} kW. At this rate the accumulated solar input to the planet in just four days exceeds the energy content of the fossil fuel reserves. The planetary energy balance (Fig. 2) indicates how this input is used by the planet.

One of the most notable features of this balance is that 30 per cent of the energy is reflected by the atmosphere, and thus positioning of energy collection systems *above* the atmosphere shows an immediate advantage. Two other benefits are also derived from space operation, namely, independence of weather conditions and, assuming a suitable orbit such as geostationary orbit, a much higher potential duty cycle with the energy collection system being in sunlight for more than 99% of the year. Clearly, there are associated disadvantages of space operation, the most significant being the complexity of the space operations required, and also the expense of material transportation to space which must be taken into the overall cost of the energy system.

SPS SYSTEM

An outline of the present SPS system concept is shown in Fig. 3. This system has been derived in the US from two parallel studies over the last three years funded by NASA and the US Department of Energy to the tune of £10 million. These studies were performed principally by Rockwell International and Boeing Aerospace.

The main elements of the satellite system are the photovoltaic solar cells and the microwave antenna system. Both of these are mounted on a carbon fibre composite structure. The total mass

of the system lies between 30 and 50 million Kg. Clearly, a system on this scale cannot be launched in a single unit as conventional satellites are at present, indeed the implementation of SPS requires the development of a new fleet of fully re-usable space transport vehicles for the movement of both cargo and personnel to GEO for the fabrication in space of the satellite. The development of these vehicles is essential if energy derived in this way is to be competitively priced relative to other, albeit depletable, energy sources.

At present, launch costs for material are around £800/kg; with the advent of shuttle, cost should drop to £200/kg. The SPS transportation system should reduce this cost to less than £25/kg. To achieve these costs SPS requires four types of vehicle, each for a specialised task. Two of these (Fig. 4) are required for launch activities from earth to a low earth orbit (around 500km) staging base (Fig. 5). One is for cargo, with a payload of 424 tonnes (Saturn V, used in the manned lunar Appollo missions, had a payload capability of one-quarter of this); the other, an uprated version of shuttle, has the ability to carry 75 passengers.

The other two vehicles are used for orbital transfer to GEO. The cargo vehicle is electrically powered and carries some 4,000 tonnes, taking 180 days for the round trip. Clearly, passenger transfer must be in a much shorter period than this and thus a chemically propelled vehicle is proposed, taking less than a day for a one way trip; 160 passengers may be transferred in a single flight.

Cursory examination of these vehicles seems to suggest that great strides in technology advancement will be required to realise these vehicles. However, one must remember that the original versions of shuttle were to be fully reusable (an essential for the SPS launch vehicles). The only reason for shuttle not now being fully reusable was the limited funding available for the shuttle development programme. In addition, large sums have been invested by NASA into electric propulsion. Thus much of the fundamental development work that would be required for the cargo orbital transfer vehicle, has already been performed. Clearly, the amount of work still to be performed in advancement of vehicle technology must not be underestimated, indeed the cost of development is estimated to be 40 per cent of the overall SPS cost.

THE SATELLITE

Returning to the satellite itself, this consists of some 10,000 million individual solar cells. The voltage generated across each cell is less than half a volt, clearly much too low to be of practical use for power raising, and therefore the cells must be connected in so-called "strings" of cells in a series/parallel arrangement. This arrangement is the standard method used on solar arrays for satellites, however, the string length is totally different. For satellites such as UK VI, launched last year, the voltage required dictated a string length of approximately a quarter of a meter, however, for SPS the string length is in excess of 5km! These strings, generating some 2000 amps at 40kV, feed into the main 8m wide aluminium conductors running the length of the satellite. These conductors run to the end of the satellite where the microwave antenna is situated.

The antenna is mounted on the solar array structure by means of a rotary joint. This joint accommodates the diurnal variation in position, relative to the satellite, of the sun and earth, and thus the joint rotates once in 24 hours.

The antenna is 1km in diameter and consists of 100 thousand radiating waveguide elements. R.F. power is generated from the d.c. supplied by the solar array, by the use of klystrons. The relative phasing of these klystrons is controlled so that the beam may be focused on the ground receiving site. The signal for this phase control is generated at the receiving site; removal of this

Fig. 2. The planetary energy balance.

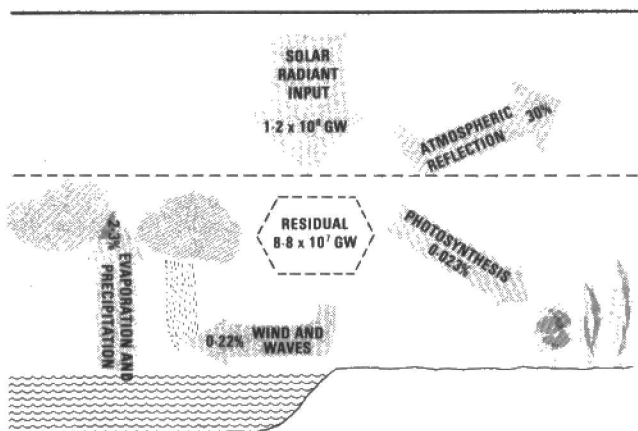


Fig. 3. The present U.S. Solar Power Satellite Concept (Courtesy NASA).

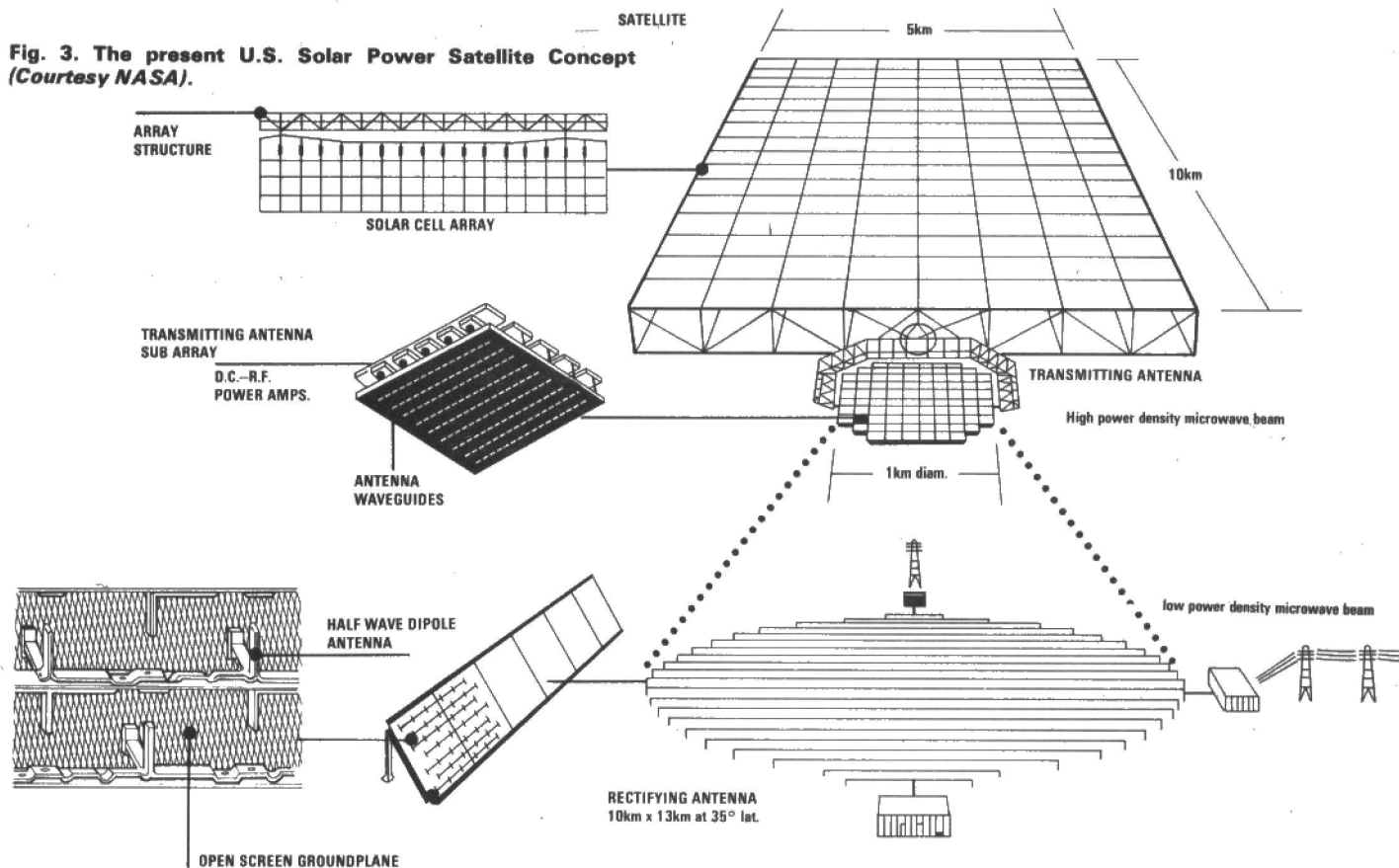


Fig. 4. Vehicles required for SPS launch activities: (a) The heavy lift launch vehicle; (b) The personnel launch vehicle; (c) The present shuttle system (for scale).

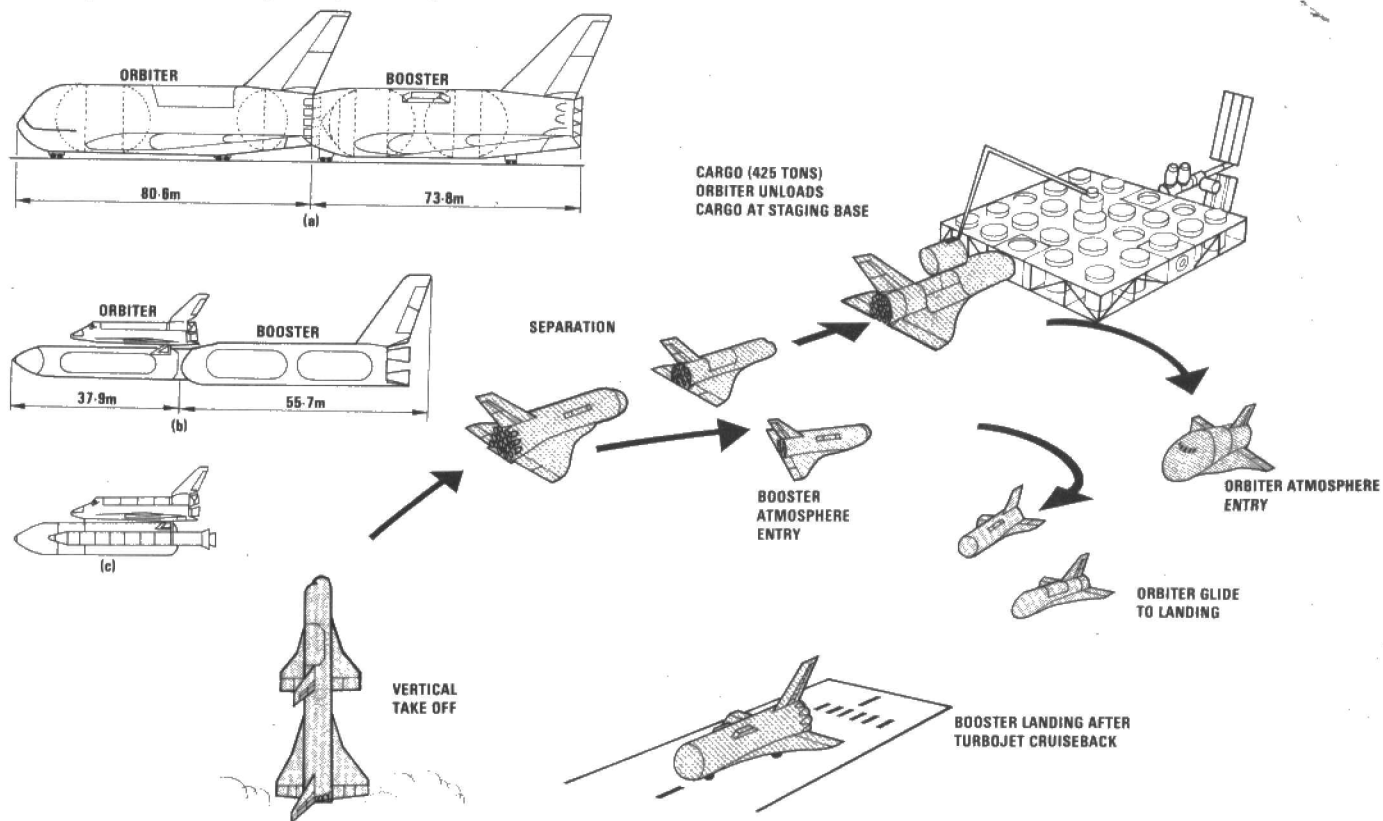


Fig. 5. Activities associated with the low earth orbiting staging base (Courtesy NASA).

signal automatically defocuses the beam to a safe microwave radiation level over a large area. The frequency for the r.f. power link (2.45GHz) was chosen so that there would be minimal dependence upon atmospheric conditions, and also to minimize interference effects on the already crowded radio bands. The peak microwave power density is 23mW/cm² so that ionospheric heating effects should not be significant.

GROUND SITE

The ground site consists of approximately 10¹⁰ dipoles with associated diode rectifiers together with a power distribution system feeding to a fairly conventional power grid interface. The power input to the grid network would be 5GW—or nearly four times the designed output from the Dungeness B AGR still under construction. So that this power might be received in the UK, the antenna required would be an ellipse some 20km in a North-South direction and 10km in an East-West direction.

The size of the sites increases with distance from the equator due to projection effects of the beam onto the earth. Clearly, the availability of sites of this size on the UK land mass is virtually non-existent and thus, in the past, off-shore siting has been proposed. More recently, study with the UK has shown the feasibility of splitting the microwave beam into several components. This has the advantage of smaller individual receiving sites thus making their placement on land, or possibly in river estuaries, feasible, with also the possibility of delivering power to where the power is actually required and thus reducing transmission costs.

The overall end-to-end efficiency chain for SPS does not, at first sight, appear impressive. In order to obtain the input of 5GW to the grid, the satellite system intercepts a total of 71GW, an overall efficient of 7 per cent. The best thermal efficiencies for conversion of fossil fuels to electricity are some five times this value. However, if one considers the energy payback ratio, namely the ratio between the total electrical energy delivered over the lifetime of a power plant to the primary, non-renewable energy required to construct and operate the power plant, then SPS comes to the fore.

Table 6 shows the energy ratio comparison between coal fired power plants, nuclear power plants and SPS, each taking into account operational energy requirements. The figures shown in the table were derived in the early part of the US SPS study. The range shown for SPS is as a result of the uncertainties associated with the methods used for component manufacture. More recent estimates show SPS to be in a more favourable position still, with energy ratios approaching the value of 20. The important point to realise from the table is that both the fossil fuel power station and the nuclear fission power station generate less electrical energy during their lifetime than the energy required to construct and operate them.

Table 6. Energy Ratios

Power plant type	Energy Ratio
Coal fired	0.31
Nuclear (Light Water)	0.24
SPS	0.5–9.0

COST

The cost estimates available for SPS for the first operational system, together with all the research development and test programmes, are close to £43 billion. This investment, required over a twenty year period in order to have an operational system by the turn of the century, would be less per year than the combined UK fission programme and the U.S. breeder programme. Subsequent systems, built at the rate of *two per year*, would cost around £1,250/kW, comparable to the AGR costs (including fuel) of £1,135/kW.

It is no longer possible to develop an energy system and combat the environmental problems subsequent to power generation. Within the US programme, considerable effort has been expended in evaluation of environmental issues. At the recent review of the SPS activities in the US (April 1980), 44 of the papers presented considered various environmental aspects. This represented a quarter of the overall presentation and covered topics such as potential microwave health hazard, ionospheric and atmospheric disturbance due to both microwave radiation and transportation activities, and the effects of possible interference on other r.f. users. Clearly, SPS will not go ahead without a fundamental understanding and solution of potential environmental problem areas. As yet no environmental hazards, nor system "show stoppers" have been identified.

So, how could SPS fit into a UK energy policy? As outlined above the principal problem for the UK is the relatively large areas of land (or sea) required for suitable ground site location. By a combination of both multiple beams and off-shore sites it appears feasible for the UK to receive SPS generated power. Another area which must be considered is how much SPS power could be used in the UK. This is driven by the combination of how many ground sites can be found and how many satellites can be suitably located in GEO.

Assuming suitable off-shore sites can be found (clearly UK expertise in off-shore oil platforms is useful here), then one only has to consider what space is available in GEO. An analysis along these lines indicates that a reasonably conservative estimate of some 30GW could be obtained. The total installed electrical power generation in the UK is nominally 67GW, however, the average power supplied during 1979 was only 32GW.

Clearly, SPS has considerable potential ability to offset the coming UK electrical energy crisis in the next century. It must be emphasised, however, that the solution to the electrical energy problem, proposed here to be aided by SPS, and by others using nuclear breeder reactors, does *not* solve the energy problem as a whole. Less than a quarter of our primary energy usage is electrical; we must still solve the problem associated with the remaining three quarters. ★

Readout...

The SIS and Velikovsky

Sir—I have followed the controversy in your columns regarding the ideas of Immanuel Velikovsky with interest as this Society has been investigating his work for some years in the columns of its *Review* where papers, both pro and con, have appeared by astronomers, physicists, archaeologists and other scholars.

I note that you have decided to terminate the correspondence on the topic and would agree that your letters column does not really have the space to deal with these complex matters in any detail, but I also note that Mr. Hyde is to be given space to reply to the letters and in the light of his strong views on the matter he is quite likely to raise new aspects of the controversy. In view of this, and in fairness to your readers who may be interested, perhaps you would consider adding some sort of editorial note to Mr. Hyde's comments drawing attention to the existence of the SIS as a forum for the Velikovsky debate? I would be happy to give further information on any aspect of the debate on catastrophism to any of your readers who contacts me at the following address.

Brian Moore A.L.A.
Society for Interdisciplinary Studies,
Central Library,
Clarence Road,
Hartlepool,
Cleveland.

Interfacing COMPUKIT

Part 1 D.E.Graham

THE COMPUKIT UK 101 is one of the few personal computers with 8K BASIC and full keyboard that does not have an input/output port for interfacing external devices. In this series we propose a remedy for this in the shape of an Address Decoding and Port Module which plugs directly into the CompuKit's expansion socket. It is also Superboard II compatible.

The Module has been designed with flexibility in mind, and as well as housing an MC6821 Parallel Interface Adaptor (PIA), which gives two 8-bit input/output ports, the board also provides 7 uncommitted address-decoded *read*, and 14 decoded *write* lines, each of which may be used with interfaces of the reader's choice, and a pair of specially decoded lines that will directly interface an AY-3-8910 or 8912 PSG. In addition there is on-board address decoding for a further 6 blocks of 16 memory locations; again these are completely uncommitted, and each could be used to enable devices with up to 16 independent registers, such as the 6522 Versatile Interface Adaptor, details of which will be given later in the series. The board also houses an independent 5 volt regulated power supply which may be used to run a limited number of external circuits.

During the series the principles of interfacing the CompuKit using various devices will be developed, and circuits will be given for a range of interfaces that may be plugged directly into the Decoding Module. Amongst these will be featured interfaces for joysticks, i.d.r. light sensors, 7-segment l.e.d. displays, audio generators, power controllers, and D/A and A/D converters. Software support for each will also be discussed.

The first part of the series is devoted to the Decoding Module itself.

DECODING PRINCIPLES

The 16 address lines of the CompuKit can be configured in 2^{16} or 65,536 different ways, or in other words it can address 65,536 different memory locations. To pick out just one of these, gating circuitry must be used. The circuit in Fig. 1.1, employing a single 16-input AND gate, would give a high output if, and only if, each of the address lines was simultaneously high. The CompuKit's address lines are active-high, so that the circuit could be used to provide a Chip Select signal when the address FFFF hex (or 65,536) was put on the address bus by the CompuKit's CPU. Different addresses could be decoded by simply placing inverters between chosen address lines and the gate inputs. Putting an inverter in lines A0 and A4, for example, would decode for the address FFEE hex (65,519 decimal). In Table 1.1 we give a listing of a hex to decimal/decimal to hex converter that may prove useful for calculating addresses on the CompuKit.

COMPONENTS . . .

DECODING MODULE

Resistors

R1, R2	1k $\frac{1}{4}$ W (2 off)
R3	220 $\frac{1}{4}$ W
R4-R6	10k $\frac{1}{4}$ W (3 off)

Capacitors

C1	2200 μ 15V
C2, C5	100n disc cer. (2 off)
C3	10 μ 15V
C4	100 μ 15V
C6	1000 μ 15V
C7	10 μ 15V

Diodes

D1-D4	1N4001 (4 off)
D5	5V 1-2W Zener

Integrated Circuits

IC1	74LS133
IC2, IC4	74LS138 (2 off)
IC3	74LS154
IC5-IC7	74LS04 (3 off)
IC8	74LS03
IC9	6821
IC10	7805

Miscellaneous

2 off	40-pin d.i.l. socket
5 off	16-pin d.i.l. socket
2 off	24-pin d.i.l. socket
4 off	14-pin d.i.l. socket
1 off	40-pin d.i.l. plug
2 off	22-pin 0.1in. edge connector
2 off	25-pin 0.1in. edge connector
1 off	24-pin d.i.l. plug
2 off	16-pin d.i.l. plug
2 off	8T28 to plug into CompuKit
Ribbon cable	
1A 20mm slo-blo fuse and p.c.b. holder	
push-to-make switch.	

The ENABLE line of Fig. 1.1 could be used to trigger a data latch (such as the 7475) to latch data appearing instantaneously on the CPU's data bus for use by some external device. In practice, in order to ensure that the ENABLE pulse comes at exactly the right instant, it is desirable to make it conditional on CompuKit's ϕ 2 clock line going high. Fig. 1.2 shows a circuit using a 17-input AND gate that would decode for the address EF18 hex (61028 decimal). This is a

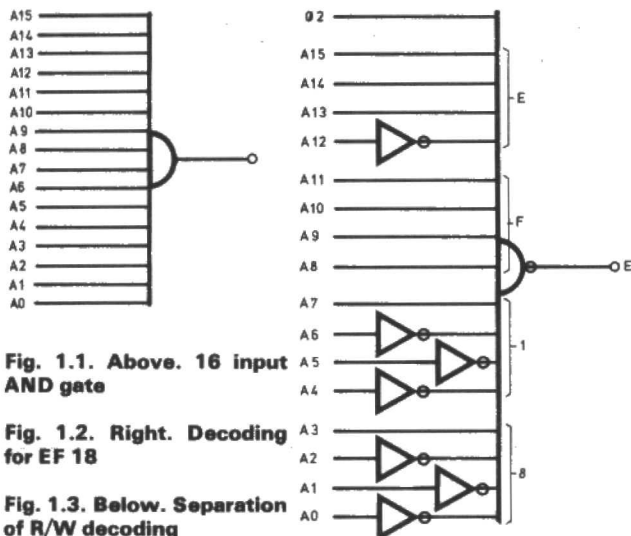


Fig. 1.1. Above. 16 input AND gate

Fig. 1.2. Right. Decoding for EF 18

Fig. 1.3. Below. Separation of R/W decoding

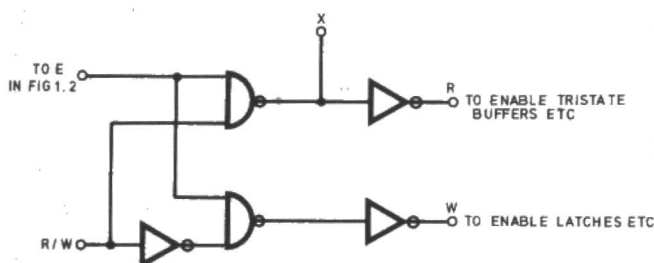


Fig. 1.4. 6821 pin-out

quite arbitrary address, and clearly any of the Compukit's 65,536 addresses could be decoded in this way; although of course since 17-input AND gates are not readily available, one would be forced to use a combination of gates to achieve the same effect in a practical circuit.

There are two further factors which must be considered in decoding for an interface, both of which relate to the R/W (Read/Write) signal. The circuit of Fig. 1.2 will give an output at any time that the address 61208 appears on the address bus. Thus, executing POKE 61208, X or Y=PEEK (61208), would both cause an output from the decoding circuit. But in most applications it is useful to distinguish between read and write operations. If, for example, we are using the signal to trigger a set of latches to give a data output, we will only want this to occur in response to a POKE command, whereas if it were used to turn on a tristate buffer for the input of data to the CPU, we would want this to occur exclusively in response to a PEEK statement.

```

90 REM HEX-DEC-HEX CONVERTER
95 REM PE UK101 INTERFACING PROG NO 1
100 FORA=1TO16:PRINT:NEXT
110 PRINT,"HEX-DEC-HEX CONVERTER"
115 PRINT:PRINT:PRINT:PRINT
120 PRINT"      IS DATA HEX OR DECIMAL ?"
125 INPUT"      ENTER H OR D";Y$
130 IFY$="D"THENGOSUB550:GOTO165
140 IFY$="H"THENGOSUB550:GOTO350
150 PRINT:PRINT"      NOT RECOGNISED: ENTER AGAIN"
160 GOTO120
162 REM
163 REM DEC TO HEX ROUTINE
164 REM
165 PRINT:PRINT:PRINT
166 INPUT"      DECIMAL DATA PLEASE";N
168 IFN=0THEN350
170 A=INT(N/4096)
180 A1=A*4096
190 B=INT((N-A1)/256)
200 B1=B*256
210 C=INT((N-A1-B1)/16)
220 C1=C*16
230 D=N-A1-B1-C1
240 X$="0123456789ABCDEF"
250 PRINT,"HEX EQUIVALENT= ";
260 PRINTMID$(X$,A+1,1);
270 PRINTMID$(X$,B+1,1);
280 PRINTMID$(X$,C+1,1);
290 PRINTMID$(X$,D+1,1)
300 GOTO165
350 REM
360 REM HEX TO DEC ROUTINE
370 REM
390 PRINT:PRINT:PRINT
400 INPUT"      HEX DATA PLEASE";H$
402 IFH$="0"THEN165
403 IFLEN(H$)<>4THENPRINT:PRINT"      4 DIGIT FORMAT ONLY":GOTO400
405 N=0
410 X$="0123456789ABCDEF"
420 FORJ=1TO4
430 FORI=1TO16
440 IFMID$(H$,J,1)=MID$(X$,I,1)THEN460
450 NEXTI
455 PRINT:PRINT"      CHARACTER NOT IDENTIFIED - RE DO"
456 GOTO390
460 N=N+(I-1)*16*(4-J)
470 NEXTJ
480 PRINT,"DECIMAL EQUIVALENT= ";N
490 GOTO390
500 END
550 PRINT:PRINT:PRINT"      NOTE THAT ENTERING A ZERO WHEN"
560 PRINT"      DATA IS REQUESTED REVERSES FUNCTION"
570 RETURN

```

Table 1.1 Hex/Dec. and D/H converter program

Table 1.2. Compukit's Memory Map showing gaps

Address	
0000-02FF	Scratchpad RAM for operating system
0300	Start of Basic Workspace
1FFF	End of On-board RAM
9FFF	End of Possible Ram expansion
A000-BFFF	Basic Interpreter
D000-D3FF	Video RAM
DF0D	Polled keyboard
F000, F001	ACIA serial port
F800-FFFF	Monitor ROM

Differentiation between the two can be achieved by using the R/W line at Compukit's expansion socket. This goes high during a Read Cycle, and low during a Write Cycle. The configuration in Fig. 1.3 would derive two separate Chip Select lines from the output of the circuit in Fig. 1.2, one for a Read to the address 61,208, and one for a Write. As may be seen, even though the two resulting decoded lines share the same address in the Compukit's memory map, they could be used for entirely different purposes. The Write might be used to trigger latches driving a D/A converter, while the Read might

trigger tristate buffers to feed the CPU with the counting registers of an external clock, for example.

Finally, in our decoding circuitry we must include a means of controlling the DD or Data Direction line of the Compukit. This determines the direction in which data is allowed to pass through the two 8T28 data buffers on the Compukit's main board. Note, incidentally, that while these two i.c.s are essential in any use of the data bus at the expansion socket, they are not provided in the basic UK101 kit, and must be purchased separately. With the DD line high, data can pass from the CPU to the expansion socket, but not in the reverse direction. When it is low, on the other hand, the converse is true. With no external signal on this line, it is kept high by Compukit's on-board resistor network R9 R74. If we did not service the DD pin at the expansion socket, we could successfully write data to external devices with the circuit of Figs. 1.2 and 1.3, but even though the R line of Fig. 1.3 would go high when a PEEK(61208) was executed, no data from the tristate buffers, or whatever else was enabled, would actually get to the CPU data bus. This could be remedied by connecting point X in Fig. 1.3 directly to the DD pin of the expansion socket. This would bring DD low only when a Read instruction was carried out at the given address, and the associated interfaces could then be both written to, and read from, in a satisfactory manner.

THE DECODING MODULE

The Decoding Module requires a 128 byte address block, a requirement easily met within the Compukit's memory map. This is reproduced in table 1.2, and it may be seen that the Compukit possesses unused blocks at C000-CFFF, D400-DEFF, DF01-EFFF and F100-F7FF hex. For reasons of simplicity we have chosen to locate the module between EF80 and EFFF hex (61,312-61,439 decimal). This falls immediately below the serial port at F000 hex. An address map of the major 8 blocks of the module is given in Table 1.3.

Table 1.3. Address Map of Module

Base Address of (Hex)	Block (Dec)	Block Number	Function
EF80	61312	BL0	Base address for 8 decoded lines
EF90	61328	BL1	Base address for PIA block
EFA0	61344	BL2	Free Block
EFB0	61360	BL3	Free Block
EFC0	61376	BL4	Free Block
EFD0	61392	BL5	Free Block
EFE0	61408	BL6	Free Block
EFF0	61424	BL7	Free Block

The board uses a combination of edge connectors and d.i.l. sockets for external connections, and the pin-outs of these are given in Tables 1.4-1.8. Edge connector SK1 carries the 40 leads from the Compukit's expansion socket, and the wiring between these should be kept as short as

possible. The 40-pin socket SK2 allows for further expansion of the Compukit, and has the same pin-out as Compukit's own expansion socket. The two 16-pin d.i.l. sockets SK3 and SK4 carry ports A and B of the PIA, respectively, together with associated control and power supply lines.

The decoded lines produced by the Decoding Module are taken out through the 24-pin d.i.l. socket SK5, carrying six Write and two Read lines, and the 2 x 25 pin edge connector SK6 which carries the remainder. Both SK5 and 6 also

Table 1.4. Connections to edge connector SK1.

UPPER ROW			LOWER ROW	
SK1 pin	Function	Connection to compukit exp. soc.	Function	Connection to compukit expansion
1	A2	12	GND	40
2	A1	13	GND	39
3	A0	14	GND	38
4	A3	15	GND	37
5	A4	16	n/c	—
6	A5	17	n/c	—
7	A6	18	R/W	32
8	<u>TRQ</u>	1	O2	31
9	<u>NM1</u>	2	A15	27
10	DD	3	A14	26
11	DO	4	A13	25
12	D1	5	A12	24
13	D2	6	A11	23
14	D3	7	A10	22
15	Spare	11	A9	21
16	A8	20	GND	30
17	A7	19	GND	29
18	n/c	—	GND	28
19	n/c	—	D7	33
20	GND	8	D6	34
21	GND	9	D5	35
22	GND	10	D4	36

Table 1.6. SK3 and 4 of PIA.

1	GND	16	ADO
2	CA1	15	AD1
3	CA2	14	AD2
4	GND	13	AD3
5		12	AD4
6		11	AD5
7	Vcc	10	AD6
8		9	AD7

SK4—PORT B of PIA is identical

carry Vcc and the data bus, and in addition SK6 carries address lines A0-A3, O2, NM1, TRQ and RESET to allow full use of the six 16-byte blocks.

Next month we will deal with the circuit operation of the Decode Module, showing the printed circuit board layout and component overlay. We shall also cover the operation of the PIA, and the construction and testing of the Decoding Module; and will look at the inputting of data to the COMPUKIT, both via the PIA, and sets of tristate buffers.

Table 1.7. Connections to SK5.

GND	1	24	W10
GND	2	23	D6
GND	3	22	D4
D7	4	21	D1
D5	5	20	D3
DO	6	19	W12
D2	7	18	W14
W11	8	17	GND
W13	9	16	GND
W15	10	15	GND
Vcc	11	14	R5
Vcc	12	13	R4

Table 1.8. Connections to SK6 edge connector.

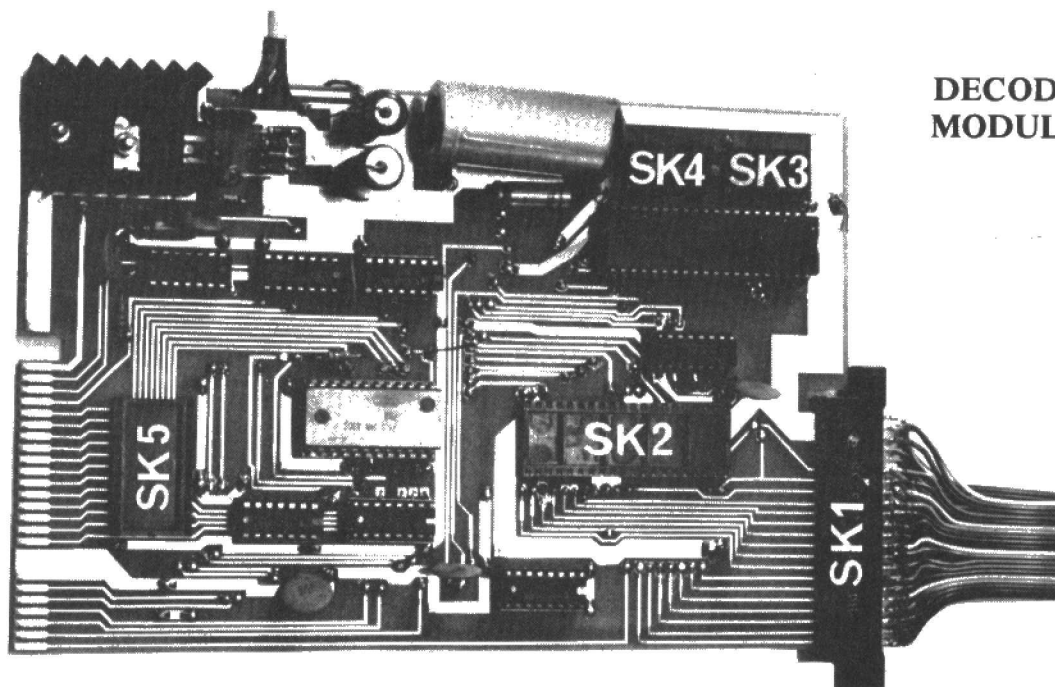
	upper (Component side)	lower
1	Vgg	RESET
2	Q2	W7
3	TRQ	W8
4	BC1	R7
5	BD1R	RO
6	W1	R1
7	WQ	R/W
8	W2	GND
9	W3	GND
10	W4	D7
11	W7	D6
12	W9	D5
13	A3	D4
14	A2	DO
15	A1	D1
16	AO	D2
17	GND	D3
18	GND	Vcc
19	GND	Vcc
20	BL4	GND
21	BL3	GND
22	R3	GND
23	R2	BL6
24	BL7	BL5
25	NM1	BL2

Table 1.9. Address within Block 1. * Note that all but the three lines with an asterisk are uncommitted, and may be used with interfaces of the reader's choice, but that, as may be seen, a number of others have been earmarked for projects within the series.

Address	Write		Read
61327	W15	To SK5	—
61326	W14	for 4 digit	—
61325	W13	7-segment	—
61324	W12	display	—
61323	W11	To SK5	—
61322	W10	To SK5	—
61321	W9	To SK6	—
61320	W8	D/A converter	—
61319	W7	A/D converter	R7 A/D converter
61318	W6*	Audio (data)	R6* Audio (data)
61317	W5*	Audio (address)	R5 to SK5
61316	W4		R4
61315	W3		R3
61314	W2		R2
61313	W1	inverted	R1 inverted
61312	W0	inverted	RO inverted

Table 1.10. Selection of Base Address of Decoding Module. * "O" indicates inverter in use.

State of A11— Address hex				Comments
13*				
A13	A12	A11 of 128 byte block		
1	1	1	FF80-FFFF	These two already used by monitor.
1	1	0	FE80-FE7F	
1	0	1	EF80-EFFF	If pads are left untouched, the module assumes this slot.
1	0	0	E780-E77F	
0	1	1	DF80-DFFF	6 possible relocation sites for Module
0	1	0	DE80-DE7F	
0	0	1	CF80-CFFF	
0	0	0	CE80-CE7F	



Semiconductor UPDATE...

FEATURING **TMOS UTN2886B TMS5100 TMS6100 R.W. Coles**

TIME FOR TMOS

The trouble with conventional power transistors is that they have a low current gain at high collector currents, and therefore you have to supply lots of base current via a driver stage. Internally connected Darlington devices help to reduce the problem by giving a three terminal device with a much higher gain, but frequency response and switching times leave a lot to be desired. Although gradual improvements are being made all the time, the fundamental problems of the bipolar power transistor are not going to disappear overnight, and attention is now being focussed on the alternative, MOS, power transistor technologies.

MOS devices offer very high input impedances and can switch large currents in a fraction of the time taken by their bipolar counterparts, and they are more stable at higher temperatures and easier to parallel into the bargain. They do have a special problem all of their own—they have higher on resistances than equivalent bipolar types—but this is often an acceptable price to pay for the other goodies. One confusing aspect of the power MOSFET scene is the proliferation of "new" technologies, each with subtly different characteristics. A glance through manufacturer's catalogues reveals that although VMOS is the most common variety, DMOS, HEXMOS, and other unnamed variations are also available.

The traditional bipolar power transistor manufacturers are not standing idly by in the face of all this competition, because although relatively few power applications are using MOS devices at the present time, mainly because of higher cost, the chances are that up to half the bipolar market will fall to the MOSFET before long. Motorola for example, while still strongly backing their bipolar line, have conceded that MOS devices have an important future role to play by introducing a new series of MOS devices of their own. Because Motorola have entered the MOS power field as a "me too" venture, they have been able to choose very carefully between competing MOSFET technologies, and the result is a new name—TMOS.

TMOS is a variation on the vertical DMOS process, but no doubt Motorola have added some special tricks of their own. Initial TMOS transistors are *n* channel enhancement mode silicon gate devices, although *p* channel devices will follow. Six devices are now available with voltage ratings of up to 500V at 4A and current

ratings of up to 12A at 100V. The dice used resemble integrated circuits in that each chip consists of thousands of interconnected source regions, paralleled to minimise "on" resistance while preventing the formation of "hot spots".

The new family are available in T03 or T0220 packages with power ratings of 75W at 25°C. They are coded from MTM 560 onwards.

QUANTITY DISCOUNT?

If you need a lot of SCRs to hook your pet micro' up to lamps, solenoids or relays, you *could* use a row of T05 devices with their associated gate resistors. You may even get a quantity discount on your SCR purchase!

A much neater way to handle the problem would be to plug in one or more UTN 2886Bs from Sprague. These new devices consist of an array of SCR devices on a single monolithic substrate, packaged in a 16 pin DIL package. The package actually houses eight SCR devices, but four of these are connected as two pairs for higher current applications, making six effective SCRs available at the pin outs. The anodes of all eight devices are connected together and to pins 4, 5, 12 and 13 which also act as heat sink tabs. Each SCR (or SCR pair) has individual cathode and gate pins, and a resistive potential divider is provided internally for each gate. The current rating of each device is 800mA continuous with a 2A peak capability for the switch on surge. At higher temperatures the rating for each device during simultaneous operation reduces to 250mA, but if you need higher currents you can use the pairs, or even parallel several devices externally.

You may have noticed that full capability SCRs do not normally crop up inside integrated circuits. This is because the SCR power circuits need very different diffusions to those used for ordinary transistors. Sprague have side stepped this problem by making an integrated array consisting only of SCR devices and resistors.

I don't know how much the UTN 2886B costs, but I bet it's less than the price of eight T05 SCRs and a dozen resistors, even with the quantity discount!

SPEAK AND SELL

As we all know, microprocessors are a great gift to mankind, destined to find a place in every corner of our day to day lives as our willing helpers and obedient ser-

vants. Unfortunately, other, less enlightened sections of the community who do not share our vision of the silicon future, seem to be resisting this benign revolution! These people, unable to use a simple ASCII keyboard, or understand simple direct VDU messages such as "WHAT?" and "ERROR 04 IN 340" are attempting to impede the great march forward by refusing, without proper justification, to buy appliances which use them.

Well, the bountiful micro' can accommodate even these deviants, and micro' manufacturers eager to sell their chips by the shovelful, have the answer ready. In future, microprocessor systems will be able to talk to their masters in ordinary English—even Devonshire!

If you have seen the Texas Instruments' Speak and Spell learning aid for children, you will already be aware of the power of microprocessor speech output. (Don't look too closely at earlier models which encouraged kiddiwinks to spell "grey" as "gray", and other howlers—the new Oxford English version is now available). Behind this Texas toy is an ordinary four bit micro' and a speech synthesis chip set using a patented Texas technique called Pitch Excited Linear Predictive Coding. Until recently Texas have kept these chips, and their technology, all to themselves, but now to aid the revolution they have released the devices for use by other manufacturers, and have also produced complete circuit boards, using the chips, which can be plugged into a microprocessor system to give it the power of speech.

All you need to get your micro' talking is a TMS 5100 PELPC synthesiser, a TMS 6100 ROM to store the vocabulary of 150 words or more, and a few TTL interface circuits. Codes for twelve synthesis parameters are stored in the ROM and supplied in sequence to the synthesiser which employs a linear equation model of the human vocal tract and a prediction system to reduce the amount of data storage required. An on-chip 8 bit digital-to-analogue converter is used to change the computed digital speech samples into a synthetic speech signal ready for amplification and subsequent speaker drive.

The two devices use the well tried and low cost PMOS technology and come in 28 pin plastic packages. A standard-vocabulary version of the ROM is available, but it is up to the micro' to string these words together to make useful sentences such as "WHAT?" or "ERROR 04 IN 340!"

PE MICROTUNE

...ENGINE TUNE-UP UNIT

Part Two

MARTIN KENT

CONSTRUCTION

THE MICRO TUNE has been designed to be easily assembled, but it will be as well to employ the following procedure:

Circuitry is accommodated on three printed circuit boards which plug together, and assembly should commence with the small display board. There are a large number of solder pads on the top surface of the double-sided boards, which should all be soldered as assembly proceeds to ensure circuit continuity.

The a/d convertor circuitry is accommodated on the display board to form a self-contained 200mV f.s.d. voltmeter with liquid crystal display. A double sided board is used and the upper and lower printed circuit track layouts are shown in Figs. 2.1 and 2.2, with the component layout shown in Fig. 2.3.

The display board is plugged at right-angles into the main board which contains the signal conditioning circuitry and function switches. Upper and lower p.c. track layouts are shown in Figs. 2.6 and 2.7 with the component layout in Fig. 2.8.

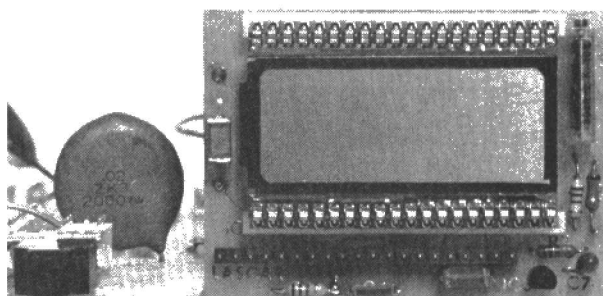
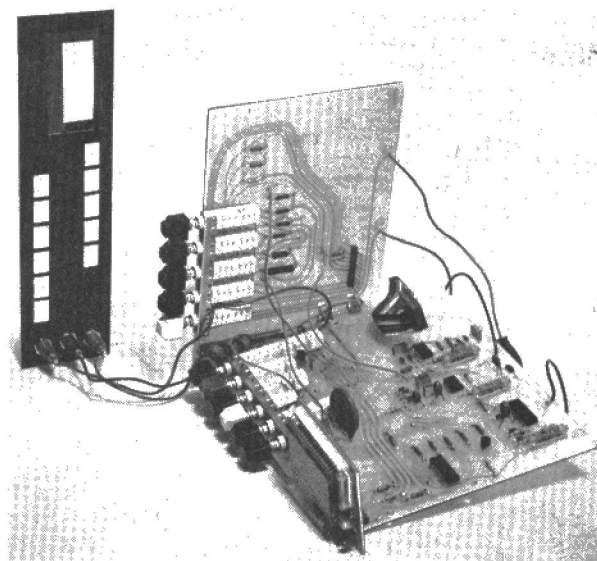
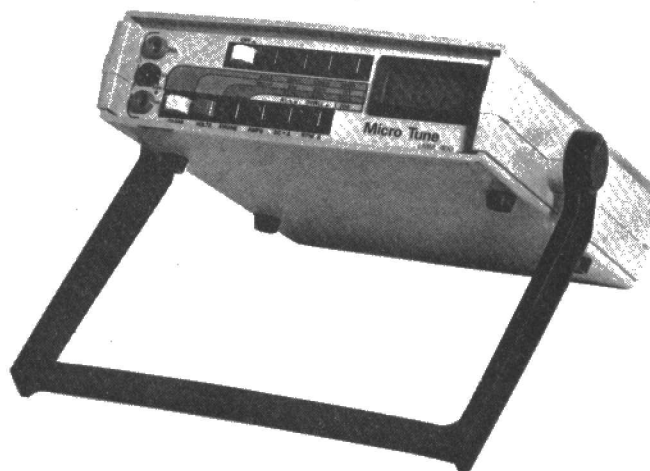
The range board is mounted above the main board on four pillars, and contains all the range setting resistors and switches. A 10-way ribbon cable connects the range board to the main board via plugs and sockets. The range board is single sided and the track layout and component layout are shown in Figs. 2.4 and 2.5 respectively.

DISPLAY BOARD

Two 10-way p.c.b. mounting plugs with long pins are inserted from the front of the board and ultimately used to plug the display board at right angles to the edge of the main board. When soldering the plugs in place, care should be taken not to allow solder onto the pin surfaces. The two strips of 20-way soldercon pins used for mounting the L.C.D. should be fitted into the insulating nylon nests, and after soldering in place, the connecting bars may be broken away from each strip by gradual bending.

Two through-board pins are used on this board and should now be soldered in place. The six fixed resistors and one variable resistor should now be soldered into place, followed by IC1, IC3 and the seven capacitors.

When soldering is complete, carefully check for correct component positioning and ensure there are no short circuits. The liquid crystal display should be carefully removed from its packaging, and gently inserted into the soldercon sockets. Note that two white dots identify the left-hand side of the display. The display pins are very fragile and it will be found easiest if one row of pins is located first, but not pushed fully in. The second row should then be located in the sockets, and after checking the location of all pins, the display may be pushed fully in. Check that the display underside is not touching any components. If this is the case, the display should be gently raised. The display board should now be complete and ready for testing.



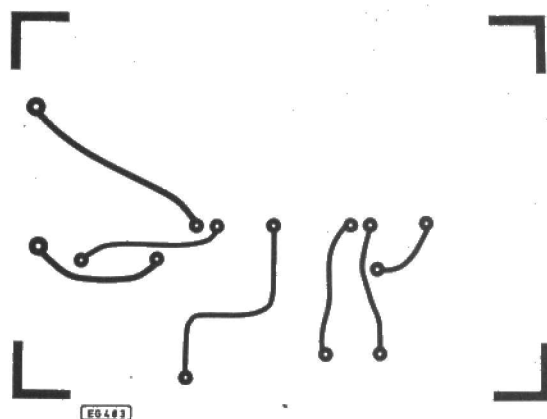
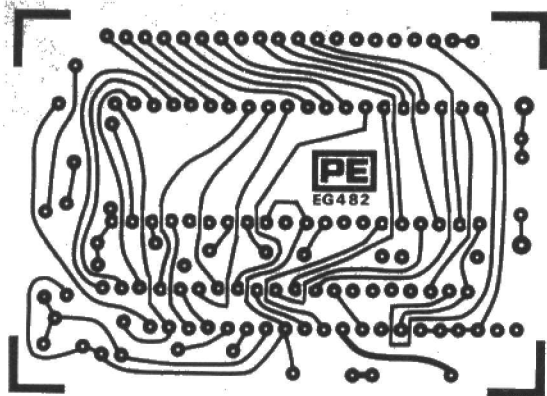
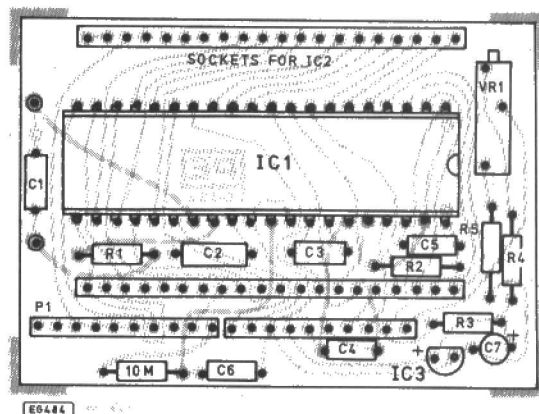


Fig. 2.1. Above. Display Board p.c.b. (copper side, actual size)

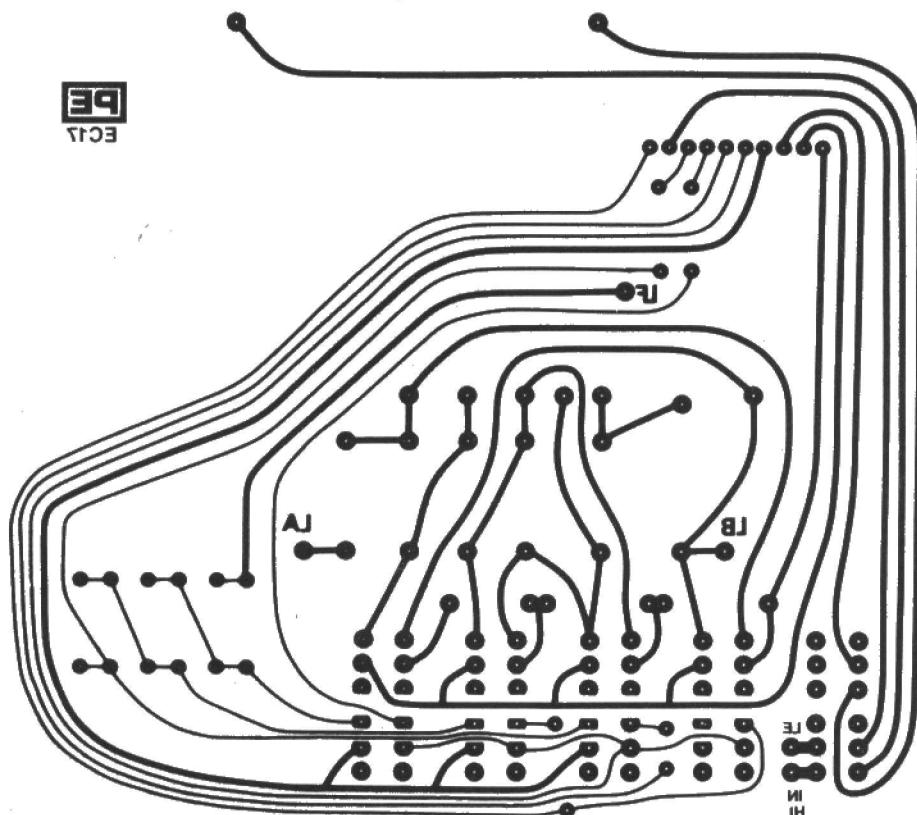
Fig. 2.2. Above Right. Display Board p.c.b. (component side)

Fig. 2.3. Right. Component layout of Display Board

Fig. 2.4. Below. Range Board p.c.b.



PE
EG484





The range board is a single-sided p.c.b. which contains the range setting resistors and switches.

The 10-way vertical plug, P2, should be positioned at the rear of the board, together with the two battery positive leads. The board should now be soldered and checked carefully.

The double-sided main board carries the function switches and the signal conditioning circuitry for d.c. measurement, resistance, dwell and r.p.m. measurement, and ancillary display driving.

There are twenty-one through-board pins to be soldered in place, followed by the switch bank and fuse holders. Note that the switch bank should be pushed fully down onto the p.c.b.

The 10-way plug (P2) should be mounted at the rear of the board, and the 15-way right-angled socket (P1) at the front of the board to the far right of the row of mounting holes.

Devices IC4-IC7 should be positioned, followed by TR1-TR2 and D1-D11. There are twenty-five fixed resistors, three variable resistors, three VDRs, one thermistor and ten capacitors which should be positioned, followed by the two battery negative leads.

Before securing the boards into the case they should be tested, and the calibration controls checked for ease of setting up.

The six insulated wire links LA-LF should be connected between range board and main board. Secure the three input terminals to the front panel and connect the three heavy duty input leads from the terminals to the range board. Connect the 10-way ribbon cable assembly between Range Board and Main Board, insert 2A fuse and locate the Display Board into the socket on the Main Board.

Set the switches to Volts, 20V, d.c., and then connect PP7 battery BT1 to the battery leads. Current consumption should be typically 2mA and the display should read 0.00. The voltage measured between Input LO and battery positive should be 2.8V + 0.4V.

Calibration may be carried out using reference sources, or by comparison with a known instrument. Alternatively, a calibration service is offered by *Lasca Electronics Ltd.*

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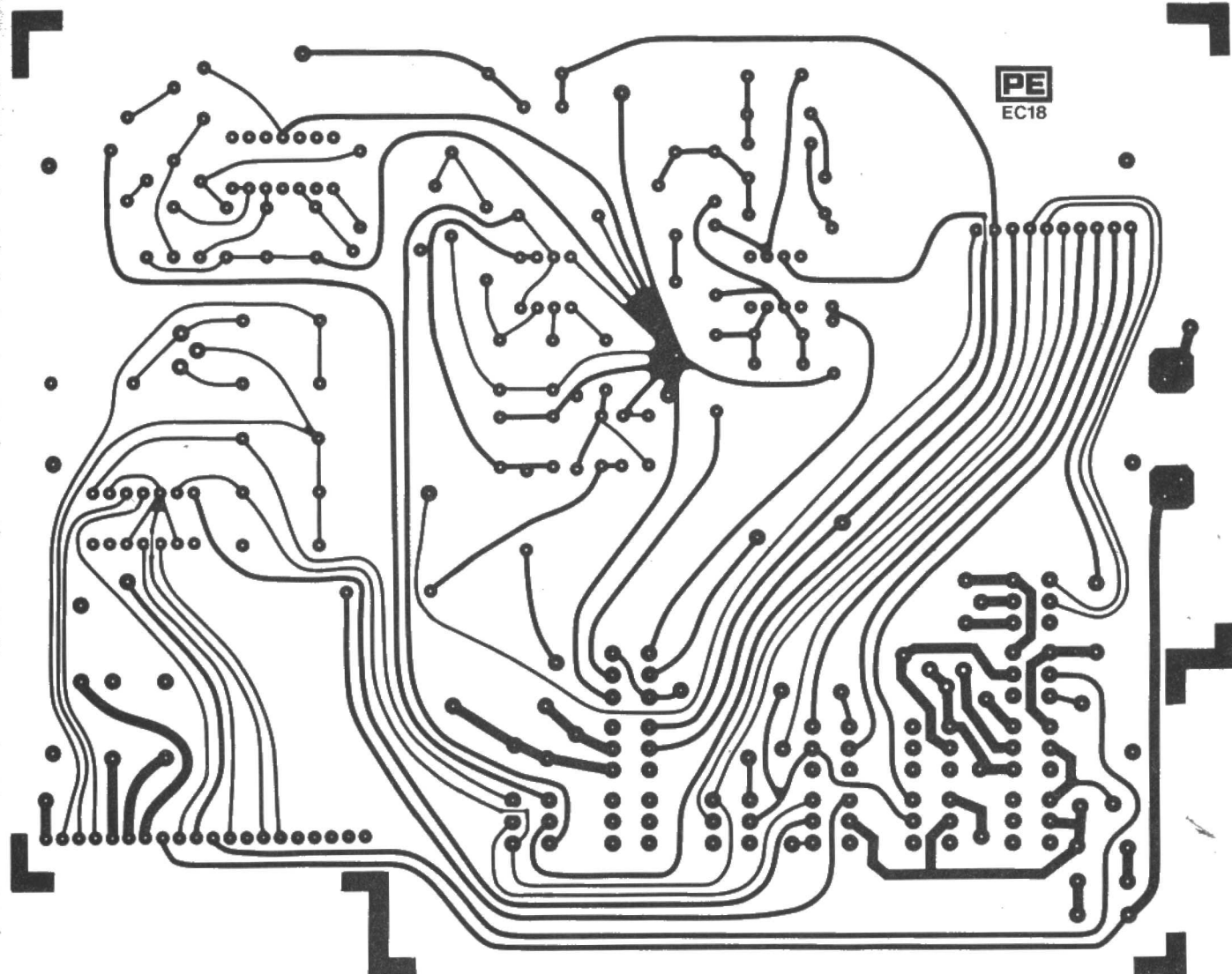


Fig. 2.6. Main Board p.c.b. (copper side, actual size)

The ratiometric method of resistance measurement does not require any calibration as it relies upon the basic DC calibration and the stable reference resistors R13-R18. With the Micro Tune switched to Ohms, DC, 20k Ω , and the input leads open circuit, the reading should be 1— indicating overrange. Short-circuit the input and the reading should be 0.00. Connect a 10k standard resistor, and the reading should be 10.00, then check the reading on the 200k and 20M ranges. Connect a 100 Ω standard resistor and check the reading on the 200 Ω range; on this range there will be an offset of three or four digits due to switch and lead resistance when the input is short-circuited.

The a.c. voltage ranges should be calibrated by switching to Volts, 20V, AC, applying a 10V r.m.s. sinewave reference and adjusting VR2 AC CAL accordingly.

To check the Current range, switch to Amps, DC, 20A, and apply a constant current source of typically 1A or 500mA between terminals 20A and Input LO. Note that no protection is provided on the Current range, and the sense resistor value is 10m Ω . The "plated" resistor, R24, is provided with a series of adjustment holes to allow the value of sense resistance to be trimmed to allow for tolerances in copper and roller-tinning thicknesses which may alter its

value. With the constant current source connected, the position of link LC may be varied along R24 until the display is correct.

To test the engine functions of r.p.m. and Dwell, a second battery is required, connected to the BT2 leads. The battery is only used when S8 Engine Function is selected, together with a range switch. A pulse generator with an output of at least 5V should preferably be used for calibrating both functions.

For calibration of r.p.m., switch to Engine, DC, RPM, 4CYL. Referring to the formula derived earlier:

$$\text{RPM} = \frac{\text{pulses/min} \times 2}{\text{number of cylinders}}$$

To simplify the calibration it would be convenient, of course, if a 50Hz frequency source could be used in the absence of a pulse generator unit. For a frequency of 50Hz, or 3,000 pulses/min, the corresponding r.p.m. for a four cylinder engine is 1500 r.p.m. Using a mains transformer with a low voltage secondary, typically 6V r.m.s., and half-wave rectification by a single diode, followed by waveform shaping with a transistor Schmitt trigger, a suitable 50Hz calibration source may be obtained. With the 50Hz frequency

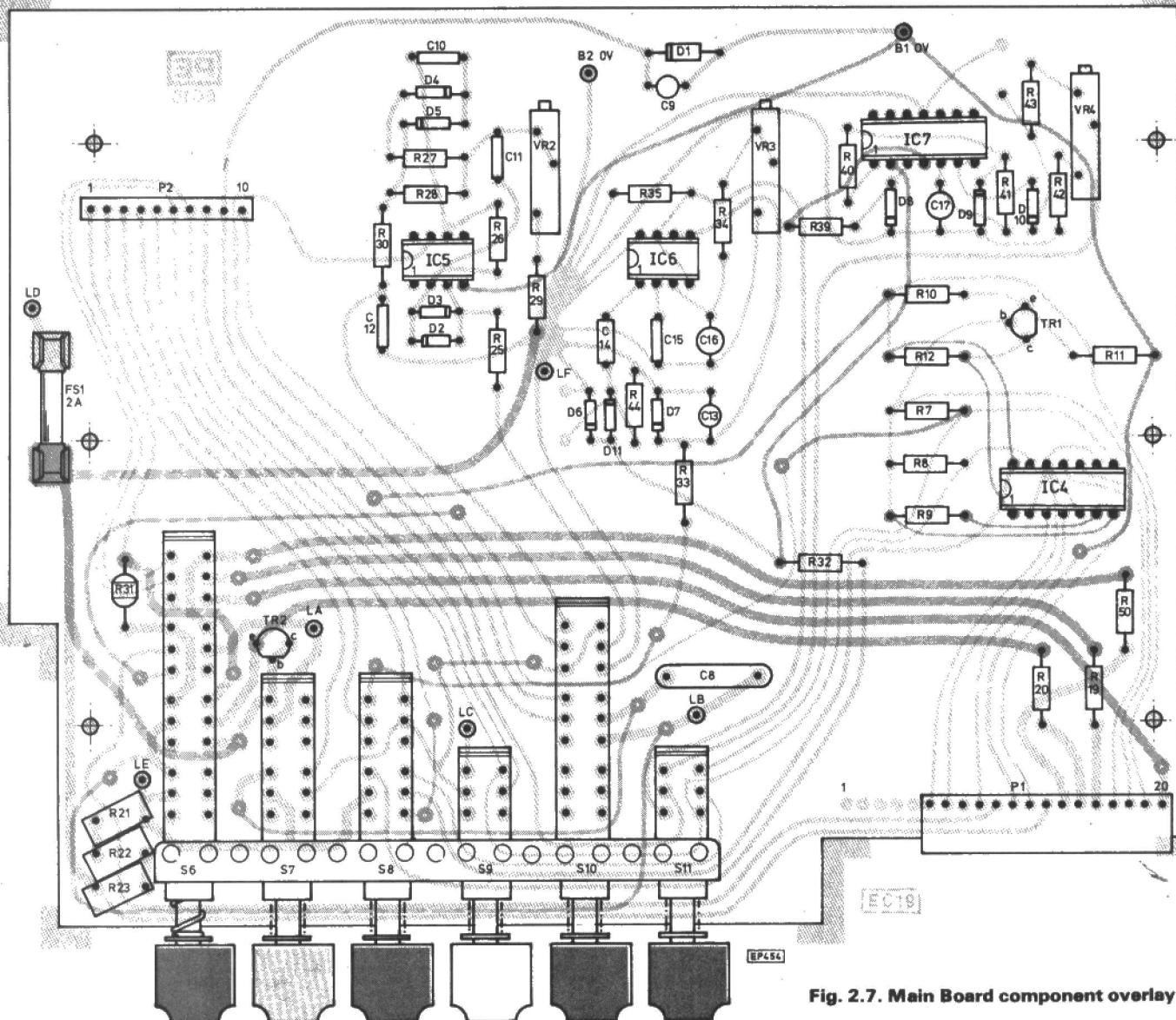


Fig. 2.7. Main Board component overlay

source connected to the Micro Tune, adjust VR3 RPM CAL until the display reads 1.50. The display reads in r.p.m. $\times$ 1000, corresponding therefore to 1500 r.p.m. Select the 6 CYL range and the reading should be approximately 1.00, the 8 CYL range should read approximately 0.75.

To test the Dwell function, a pulse generator with variable mark/space ratio output is preferable but a 50Hz square wave source is a useable substitute. On a four cylinder engine there are four lobes on the contact breaker cam resulting in a maximum points closure angle, or dwell angle, of 90deg. Switch to Engine, DC, Dwell, 4 CYL and with a 50Hz square wave input to the instrument adjust VR4 DWELL CAL to provide a display of 45.0 since the mark-space ratio will be 50:50. When the input leads are open-circuit the display should be approximately 90.0.

Reading on the 8 CYL range should be half those on 4 CYL range, and 6 CYL range readings should be two-thirds of those on 4 CYL range.

FINAL ASSEMBLY

When the p.c. boards have been tested, the front panel should be inserted into the slot in the lower half of the case. After removing the protective plastic film from the l.c.d. the main board should be secured to the case by two M3 self-tapping screws at the rear of the board. The range board is

spaced above the main board by four fibre pillars and secured by four M3 $\times$ 45 screws with washers placed under their heads. Each of the battery retaining springs is secured to moulded pillars on the lower half of the case by two M3 self-tapping screws. Position the two batteries and insert the rear panel into the slot in the lower half of the case. In order to fit the batteries, it may be necessary to cut two notches each in the p.c.b. to accept the rims of the PP7s. Attach the sides and handle assembly to the case, noting that the side of the display board engages in a slot in the right-hand side piece.

Whilst the calibration controls are still accessible, it may be advisable to check their settings, then place the case lid over the assembly. Four screws pass through plastic feet and secure the case halves together.

The position of the handle may be altered by pulling its two sides outwards simultaneously while altering the angle of the case.

USING THE MICRO-TUNE

When assembly of the instrument is complete, it will be found to be extremely versatile and suitable for use both in the lab. and when servicing cars. A guide to some applications of the Micro Tune follow:

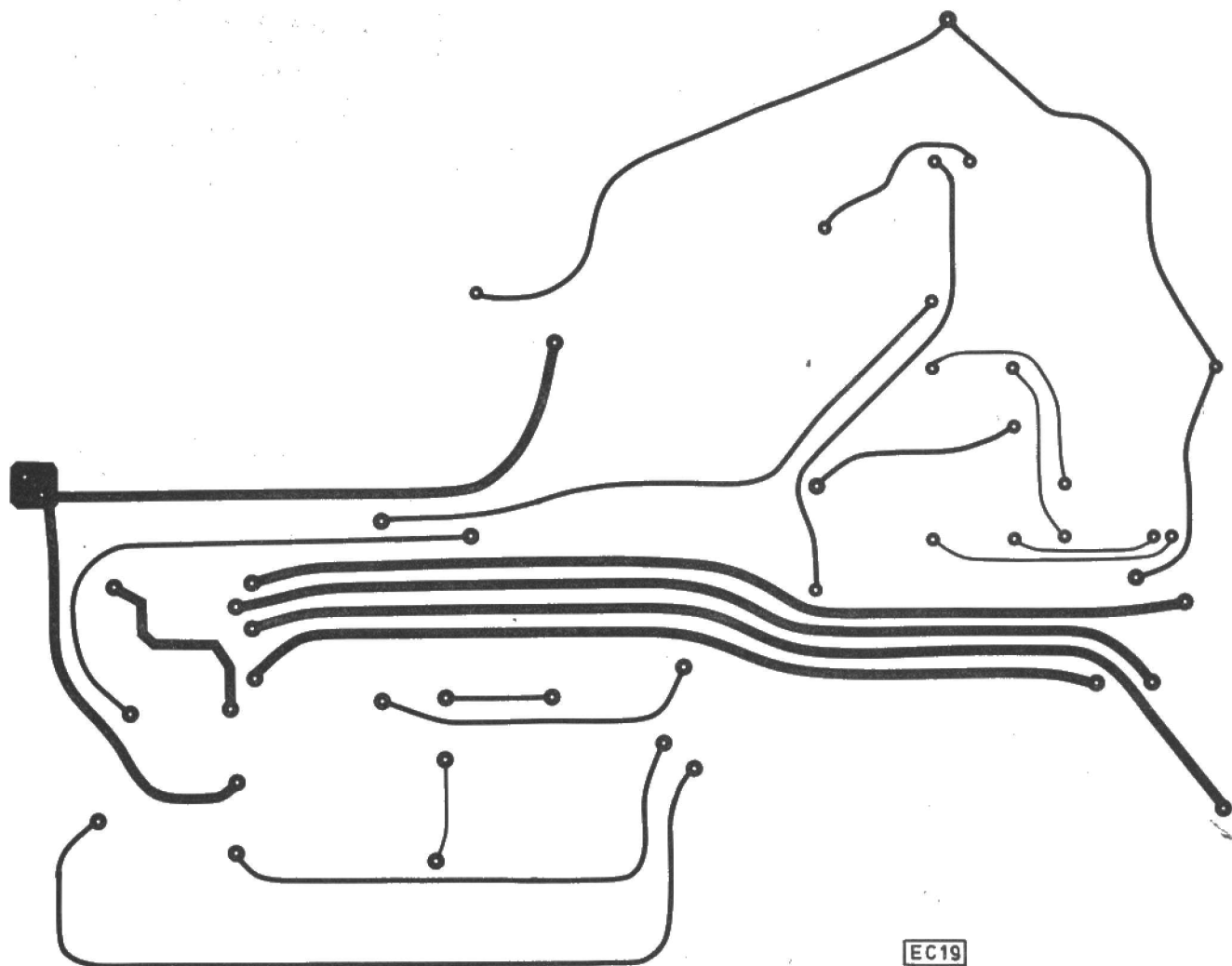


Fig. 2.8. Main Board p.c.b. (component side).

(a) Voltage Measurement

The instrument will measure from $100\mu\text{V}$ to 1kV but care should be taken not to connect it across a vehicle HT circuit, which may be 20kV .

BATTERY CHECKING

To check the condition of a vehicle battery, make sure, by using a hydrometer, that each cell is fully charged. Disconnect the HT lead from the centre of the distributor cap and ground it to a suitable earth. Switch the Micro Tune to Volts, DC, 20V , and connect it across the battery. Turn on the car headlights, heated rear window, and blower, then turn the starter for approximately 30 seconds. The cranking speed should remain constant and the battery voltage should remain higher than 9.5V if the battery is in good condition.

The instrument may also be used to test the generator or alternator output and the open-circuit voltage through the regulator.

(B) Current Measurement

A single current range of 20A is provided, with resolution of 10mA . Due to the low sense resistor value of $10\text{m}\Omega$, no protection is included and care should be exercised when undertaking current measurements. *Do not attempt to*

measure the starter motor current as this may exceed 60A . The 20A and Input LO terminals should be used, with the instrument switched to Amps, 20A .

(C) Resistance Measurement

Although protection is included on the resistance ranges, measurements should not be taken on live circuits. Continuity of cable looms may be accurately checked on the 200Ω range where resolution is $100\text{m}\Omega$.

COIL RESISTANCE CHECKS

Disconnect all leads from the ignition coil. Switch the Micro-Tune to Ohms, DC, 200Ω and connect the input leads to the two primary terminals on top of the coil (normally marked SW and CB, or + and -). The reading for a 12V coil should be approximately 4.0Ω . If the coil has a ballast resistor fitted, the reading should be approximately 1.0Ω .

To measure the secondary circuit resistance, connect one lead to the centre HT terminal and the other to the LT terminal marked CB or -. A short in the secondary winding will result in a reading below $2\text{k}\Omega$, whereas a reading above $40\text{k}\Omega$ will indicate an open-circuit secondary winding or a bad connection at the coil terminals.

POINTS RESISTANCE CHECKS

Tachometer and dwell measurements are dependant upon correct operation of the contact breaker, and it is advisable to check this first.

Switch the Micro Tune to Volts, DC, 20V and remove the distributor cap. Switch on the ignition, and crank the engine until the contact breaker opens. The reading should be approximately 12V and if this is not the case, check the connections and the points insulation.

When a satisfactory reading has been obtained with the contact breaker open, crank the engine until the c.b. is closed. If the c.b. is perfect the reading should be 0V. A reading of up to 4V is acceptable, but a higher reading suggests that the points require attention.

(D) Tachometer Measurements

The measurement of r.p.m. is very useful when tuning a car engine and the Micro Tune is easily connected across the ignition coil LT, and the vehicle chassis, with the instrument switched to Engine DC, RPM and cylinders as required.

Correct polarity should be observed. For negative earth vehicles Input LO should be connected to chassis, and Input HI connected to the coil LT trigger point. The leads should be reversed when the instrument is used on positive earth vehicles.

As with all engine tuning procedures, tests should be carried out with the engine at normal operating temperature.

DIRTY AIR CLEANER CHECK

Remove the air cleaner and ensure that the choke is open. Start the engine and adjust the carburettor to idle the engine at approximately 800 rpm. Replace the air cleaner.

If the r.p.m. changes, clean and/or fit a new filter.

If the r.p.m. remains constant, the air cleaner is efficient and working properly.

CARBURETTOR IDLE AND MIXTURE ADJUSTMENT

Set the engine to idle at the speed recommended by the manufacturer by adjustment of the throttle stop.

Adjust the mixture screw on the carburettor, until the highest steady reading is obtained on the tachometer.

Reset the engine to the speed recommended by the manufacturer. If difficulty is experienced when obtaining a second reading the manifold and carburettor should be checked for air leaks.

During the points closed, or dwell period, a magnetic field is produced around the ignition coil as the primary current builds up. If the magnetic field does not reach sufficient magnitude, due to the dwell period being too short, its collapse when the points open may not produce sufficient voltage across the secondary winding to cause a spark at the plugs.

AIR/FUEL RATIO MIXTURE

Remove the air cleaner. Set the engine to idle at approximately 800 r.p.m. Ensure that the choke is open.

Slide a flat plate slowly over the mouth of the carburettor to partially choke off the air supply.

Note the r.p.m. reading and any changes. If the r.p.m. increases as the mouth is blocked, a lean mixture is indicated. A rich mixture is indicated if the r.p.m. reading decreases.

If there is little or no change in r.p.m. reading until the mouth is almost completely blocked (typically three-quarters covered) an acceptable mixture is indicated.

(E) Dwell Measurements

For dwell measurements, the Micro Tune should be connected as for tachometer use but switched to Dwell instead of r.p.m. Start the engine and allow it to idle at a smooth speed. When the correct points are fitted and correctly adjusted, the dwell reading should correspond with that quoted in the workshop manual. On all engines the dwell angle should be constant at speeds up to approximately 1500 r.p.m., which is the point at which the advance and retard unit comes into operation.

As a guide to typical dwell angles, a note of those quoted for some four-cylinder engines is given below:

Lucas distributor	60° BLMC
AC Delco distributor	37° Ford
Autolite distributor	40° Vauxhall

If the dwell reading fluctuates, increase the engine speed slightly until a steady reading is obtained. If the dwell reading is too high, the contact breaker gap is too close and requires adjustment. If the reading is too low, the c.b. gap is too wide and should be reduced.

Slowly increase the engine speed to approximately 1000 r.p.m. and then return it to idle speed while observing the dwell reading, which should remain approximately constant, the maximum permissible variation is typically 2-3 deg.

Quickly increase the engine speed to approximately 1500 r.p.m. and then return it to idle speed whilst observing the dwell reading, which should fluctuate by only 2-3 deg.

DWELL ADJUSTMENT

Remove the distributor cap and the rotor arm, then loosen the contact breaker fixing screws so that the points are not loose, but may be adjusted with a screwdriver in the adjusting slot.

Switch on the ignition and move the c.b. with the screwdriver in the adjusting slot, until the dwell is correct while the starter motor turns over the engine.

Tighten the screws and replace the rotor arm and distributor cap. The points are now adjusted and for complete tuning it is advisable to time the engine using a stroboscope.

It may be considered preferable by some owners to remove the spark-plugs before turning over the engine, to reduce the load on the starter.

When the dwell reading is correct, the contact breaker gap should also be correct. If it is not possible to get the two right at the same time, check that the correct type of c.b. is fitted. Also check that there is no wear on the heel of the pivot, and that the spring tension is not too weak.

If the contacts are in good condition, then suspect wear on the distributor shaft bearing, advance/retard plate, or damage to the cam.

To check distributor wear, disconnect the vacuum unit and note the dwell angle at idle speed. Increase engine speed to 3000 r.p.m. and observe the dwell reading, a variation of more than 3 deg. indicates distributor bearing wear.

In these days of spiralling petrol prices it is advisable to ensure that one's car engine is correctly tuned and operating efficiently. The Micro Tune enables the car owner to tune the engine regularly while avoiding ever-increasing servicing costs. ★

CONSTRUCTORS NOTE:

Lascar Electronics offer a calibration service (£7.50 inc. VAT) and a combined trouble-shooting and calibration service (£10.00 inc. VAT) for the Micro Tune.

A complete Kit of all parts for the PE Micro Tune is available from Lascar Electronics Ltd., Unit 1, Thomasin Road, Burnt Mills, Basildon, Essex SS13 1LH (price £69.80 inc. VAT)



PLUTO

At last the speculations are over and the 'mystery' of Pluto appears to have been resolved. There have been many attempts to arrive at a satisfactory solution since Flammarion first suggested in 1879 that there was a planet beyond Neptune. Those others who also predicted, arrived at figures for size and density which varied from half the size of the Earth to twice the size of the Earth and periods from 250 years to a 1000 years.

The first direct measurement of the planet was made by Kuiper using the 82 inch reflector at Macdonald Observatory in Texas. The diameter was quoted as being 6400 miles and the mass about 80% of that of the Earth. However when Kuiper and Humason made an attempt to observe with the 200 inch Palomar telescope, a new figure for the diameter was given as 3200 miles, smaller than Mars. This was in 1950. Earlier in 1936 R. A. Lyttelton had suggested that Pluto could have been one of Neptune's moons that had escaped. This was feasible for the hold that Neptune has on Nereid is very tenuous. Nereid is the smaller of Neptune's moons. In 1956 Kuiper supported Lyttelton's hypothesis that the planet may have been an escape from Neptune.

In 1978 June 22nd J. W. Christy, at US Navy Observatory at Flagstaff Arizona, when making measurements with the 1.55m telescope noted that Pluto appeared to be elongated. Examination of plates taken in 1965, 1970 and 1971 also showed this but had been ignored because there were defects in the plates. By 1978 a fortnight after Christy made his announcement, Graham using the 401cm telescope at Cerro Tololo observatory, showed that the planet was not elongated but that there was in fact a large satellite associated with Pluto. It was provisionally called Charon. It was not however fully confirmed until April 1980 by Alistair Walker at

the South African Observatory. Pluto was due to pass in front of a star but not closely enough to occult it. However Walker observed that the star disappeared for 50 seconds. The conclusion was that it could have been occulted by Charon, the Pluto satellite.

The next episode of this intriguing astronomical serial came later in 1980. In a joint project using the 3.6m telescope at Mauna Kea, Hawaii, the cooperatively owned instrument of Canada-France-Hawaii, D. Baneau and R. Foy, have used the special technique of *Speckle Interferometry*. This a technique which has been in successful operation for some time now where light levels are very low indeed. So low are they that so many hours of exposure would be required that definition by blurring alone would make them of little value. Enough is already known about the electronic enhancement of images from satellite and spacecraft observations especially those from the Pioneer and Voyager missions

The speckle interferometry uses very short exposures in succession. The result of combining these gives a composite picture which when translated enables the separation of close celestial objects like double stars. The results of using this technique on Pluto has revealed that the satellite is in fact so large that the two bodies must surely be properly designated a double planet. The figures are that the smaller body is at a distance of 19000km from the primary body, that Pluto itself is 4000km in diameter and the smaller body, or, Charon as it must now be called, 2000km in diameter. The density of both planets is calculated to be 0.4 g/cm³. This suggests that the period is about 6.9 days the figure which was given for the rotational period of Pluto itself by Walker and Hardie in 1955. Pluto then is only 500km greater in diameter than the Earth's Moon and Charon a little larger than Saturn's moon Iapetus or the moon Titania of Uranus. So one more correction to the dimensions of the Solar System.

THE RINGS OF SATURN

New features are apparent in the rings of Saturn as disclosed by the Voyager 1 images. The latest images were taken when the vehicle was at a distance of 51.5×10^6 km from the planet. There appear, in pictures taken a few hours apart, spoke like features. These appear on the inner edge of a ring and retain their identity for a long period in spite of the fact that the inner edge of the ring is rotating much faster than the outer edge. Because these features extend over a considerable distance it is of very considerable interest to know the mechanism. It is likely that the features are not in fact solid bodies but could rather be areas where there is less material. Why? is the question to be asked here.

It must of course be taken into account that the resolution available at this distance is about 200 to 300km. When the next stepped up observation conditions which began on October 24th 1980 with the highest resolution images on the 2nd of November are analysed it may be possible to offer more details.

The last course manoeuvre was made on 6th October but there could be the need for a

trajectory check and modify on November 6th a few days after this article is being written. The Voyager flyby is expected to provide significant data about the planet. The rings have appeared smooth but when the spacecraft comes to 124000km details of their structure may be apparent as well as details about the cloud cover of the planet. It is known so far that Saturn's rotation period is 10hr. 39min. The Voyager imaging system has a greater resolution facility than the previous spacecraft Pioneer 11 when it made its close encounter. Two television cameras using 200mm and 15000mm focal length lenses will be able to discriminate to 5km on the planet itself and down to 1km on the rings. It is hoped that after passing inside the rings the effect of the rings on the radio transmissions may help to decide the size of the particles, if such there be, as conjectured, like ice covered rocks. Voyager will have passed within about 4000km of the cloud cover of Titan some eighteen hours before the actual Saturn encounter on November 12th. The extent of Titan's atmosphere will be measured by radio waves as they propagate through the atmosphere. The surface of Titan is unlikely to be seen through the clouds.

In the far Encounter-1 phase of observation, which began on October 24th, it was no longer possible for the whole disc of the planet to be accommodated in one frame. To overcome this four frames at a time were taken. The near encounter phase of the observations began on November the 13th and will end on December 15th. There will be a film sequence of this part of the mission. Signals at the time of closest encounter, November 11th with Titan will arrive at 11 pm PST. Eighteen minutes later the spacecraft will dip below the ring plane and make its closest approach to Saturn 18 hours after the Titan encounter and then will make an ascending ring crossing on the outbound trajectory and out of the Solar System.

THE SOVIET COSMONAUTS

Popov and Ryumin were out walking within 24 hours of their return to earth. They were undergoing observation at the launch site after 185 days in space. They were debriefed and offered some comment about the effects and their reaction to the set regime for their health. Ryumin thought that the 185 day mission was better than the 175 day mission and efficiency was higher. He felt this was partly due to better preflight briefing and better organised station work routine on board the spacecraft.

Both cosmonauts were of the opinion that rest days from exercise were of positive help in maintaining their stability. Boredom was a thing to be avoided. Another point was the need to have a widely varying range of tasks to avoid routine regime.

Following Frank Hyde's reply last month to the letters on the Velikovsky debate, we have received a letter from the Society for Interdisciplinary Studies suggesting that any reader who wishes to continue the debate should write to them. See Readout for details.

DISCO DESK

Part 5 BEN DUNCAN

In this final part end wiring, a suitable power supply and the setting up of the desk will be described.

CABLE LOOM

Making a neat cable loom is a skilled job; one must have a 'feel' for the flow of wires and also be able to see how the loom will take shape. It is often necessary to reroute occasional wires until the loom 'flows'. Because there is no a.c. in the vicinity, unscreened wires are permissible for the following connections:—

- 1) Crossfader to monitor and source selector switches.
- 2) Line level wires leading from the routing switches to the send return sockets.
- 3) Tone control wires.

The latter requires qualification. The relatively long wires leading to the tone controls can precipitate instability unless they are neatly routed. Although intuition suggests that screened wire would be a good way of minimising interaction between these wires, it should be remembered that the screen is also a capacitance to earth, and the phase shifts resulting from such capacitance may cause instability. The applicability of screened wires to the tone control connections can only be determined empirically; in the prototype, screened wires gave the best performance for the microphone tone controls, whilst unscreened wires were used for the music tone controls. Regardless of whether these wires are screened, they must be carefully routed to be as short as possible and mutually spaced apart.

The 12V subsystem and audio looms should be kept apart wherever possible, to avoid the induction of switch clicks, etc. Twin screened wires are used for the stereo connections. Crosstalk should be negligible here because cable lengths are relatively short and source impedances are generally low. All screens should be tied to the OV rail at *one end only*. Connecting screens to the chassis may be expedient in some cases, but susceptibility to RFI could be increased. Therefore, if there isn't a convenient OV point where the screen is to be terminated, it should be connected to OV via 7/0.2 wire. Bearing in mind the proximity of the disc input wires, single screened wire is also used to connect the turntable motors to the mains supply. It is most important that the cable used here is capable of withstanding mains voltages; medium and heavy duty types will generally be suitable. Note especially that separate cables are used for the live and neutral connections and that the screen is earthed in both cases.

Although the OV and chassis earths will be eventually joined at some point in the audio system, there is a significant impedance between the two points at r.f. Decoupling is therefore essential if RFI is not to be troublesome. This is achieved by connecting ceramic or polystyrene capacitors with values between 100p and 100n between OV and chassis earth. Convenient points are from pins 11 and 21 on all volume controls to a solder tag sandwiched between the adjacent slider body and spacer. The input sockets should also be decoupled, likewise the PSU and OV busbars and the disc input termination under the turntable (Fig. 17). Note that the disc input cables are quasi-balanced in that the screen does not carry a signal.

If possible, low noise cable (utilising a conductive plastic screen) should be used to connect the disc inputs and microphone transformer secondary to their respective cards to prevent microphony.

CROSSFADER

With reference to Fig. 18, the quad crossfader specified consists of two dual crossfaders ganged together, each with log and antilog tracks. This provides audio taper in both directions, but as the slider traverses the centre area, the audio level is relatively low. This type of action is suitable for discotheque performances which incorporate a predominance of rock and heavy metal material, where records are treated as individual entities. Discotheque operators who concentrate on soul and disco-funk, however, may wish to mix two music sources and 'double beat' as they crossfade. This can be achieved on the desk by skilful manipulation of the crossfader and music volume control, but it is also possible to alter the law of the crossfader such that the audio level remains substantially constant during crossfading. In this case, a 25k *linear* quad pot should be used. A semi audio taper is then provided by connecting resistors from the slider to the top and the bottom of the pot on each track. Experimentation will be required to determine a suitable value for these resistors, but their value will be of the same order of magnitude as the potentiometer. A more conventional method of achieving double-beating is to use separate level controls for each turntable and/or line source. Minor modifications to the circuitry are involved here and details will be given later.

In Fig. 14, note that the normally closed (n/c) relay contacts are used to switch the lamps and turntables. This ensures that a failure in the 12V subsystem does not bring the

CABLE DESIGNATIONS

Colour/type	Audio unscreened	Other	Colour/Type	Other
Red 32/0.2	—	+12V to monitor amplifier. All main +ve feeds from power input socket to barrier strip 3	Grey, pink, and Brown 7/0.2	Autofader
Red 7/0.2	—	+15V, +12V, +47V lines	White 7/0.2	L.e.d.s and meters
Black 7/0.2	—	-15V lines	Yellow 32/0.2 and 16/0.2	12V subsystem (lamps and relays)
Black 32/0.2	—	Main -ve feeds from power input socket to barrier strip 3	Audio screened	
Green 32/0.2	—	+12V subsystem 0V connections. All main 0V feeds from power input socket to barrier strip 3	Single screened 7/0.2	All mono connections, ie:—for monitor and mic circuits
Green 16/0.2 and 7/0.2	0V connections	0V and chassis earths	Single pair with foil screen (e.g. Belden 7/0.2)	All stereo connections
Orange 7/0.2	Sends	—	Heavy duty single pair screened	— Mains wiring from barrier strip 3 to turntable motors
Purple 7/0.2	Returns	—	Low noise two pair screened with conductive plastic screen (e.g. Filotex)	Disc inputs from cartridges
Blue 7/0.2	Miscellaneous	Mains neutral from power input socket to barrier strip 3 and to turntable lamps		
Brown 7/0.2				
Mains live				

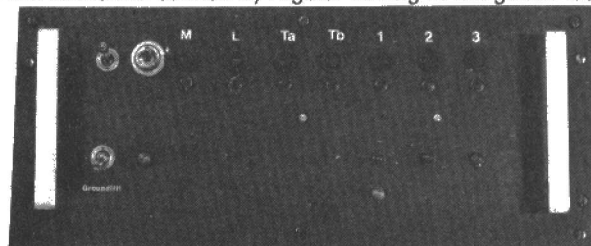
music to a standstill. The snubbers C1/R2—C8/R9 should be wired as close to their respective switches as possible; their purpose is to suppress switching clicks, particularly when the turntable motors (an inductive load) are energised. It may be necessary to wire additional snubbers directly across these motors in extreme circumstances. These may be of the same value as C5/R6 on Fig. 14. If turntable 'clicks' persist, find out whether the noise is due to inadequate suppression of the mains supply to the motors, the appropriate relay or switch; then try rerouting the mains wires leading to the turntables with a view to keeping them as far from the disc input cables as possible. If the clicks cannot be eliminated or satisfactorily attenuated, then zero-voltage switching could be used to turn the turntables on and off. Usually, however, good suppression and diligent cable routing will ensure that clicks do not intrude.

With reference to Fig. 15, note that the 12V subsystem input wires are doubled up between the input socket and barrier strip no. 3. These double cables extend to the power supply, which may be 10' away in terms of cable length. In this way, excessive voltage drop is avoided.

TURNTABLE LAMPS

The turntable lamps used in this design were chosen after lengthy experimentation. Localised, high intensity lighting is essential to enable the operator to pick out record tracks regardless of how tightly they are packed and how poor the ambient lighting conditions are. Even more important is the need to be able to see the position of the stylus in relation to the end of the track. All the broadcast cartridges specified for this desk are designed with good stylus visibility in mind, but even so, lamp positioning is critical.

Lighting power requirements are proportional to the inverse square of the lamp-stylus distance but the minimum working distance is around 8in. otherwise the lamp may foul and scratch discs when they are removed from the turntable. In practice, a 15 watt mains pygmy lamp meets the criteria and has the great advantage that an additional 30 watts of power supply capacity is not required, as in the case of 12 volt lamps which are frequently used for these applications. Such a lamp can be readily shielded to prevent glare by coating one side with heat-resistant paint. The absence of a shield or shade is most useful, in that should a record be accidentally brought in contact with the lamp, little damage will result, since unlike a shade, the lamp's surface is smooth and rounded. Although goosenecks bearing mains (BC) lampholders are not readily available, standard discotheque gooseneck lamps can be readily modified by cutting off the end and soldering or gluing on a BC lampholder. Such a lampholder should preferably be brass for robustness. If the lampholder is glued to the gooseneck, it *must be earthed separately*. Wires leading down the latter should be smeared with a lubricant such as silicone grease; this limits abrasion of the insulation caused by regular flexing of the gooseneck.



Prototype p.s.u. front panel

COMPONENTS

12V SUBSYSTEM, OUTPUT ROUTING AND MONITOR SWITCHING

Potentiometer

VR1a/b — 1k dual log slide pot
(Maplin type HB00A)

Capacitors

C1-4 — 100n mylar
C5-8 — 100n, 1000V polypropylene or mixed dielectric
(Mullard 330 series)

Miscellaneous

S1, 3, 5, 6, 7, 8 Push button illuminated switches made up from RS. 339-358, 339-415 (Switch and shield)
S2 Same as above, but requires an extra switch element 339-033 and extension screws 339-049
Coloured lenses are required for the above and come in packs of three: Green—339-370, Blue 339-386, Red 339-392, Orange 339-409
S4 Three way four pole miniature rotary switch
S5 Three way three pole miniature rotary switch
SKT1-2 5 pin female XLR socket
LP1-9 T5.5 wedge lamps, 12V 100mA (RS type 586-649)
LP10-11 These are normally available with the VU meter and should be rated at 12 volts
RLA1-4 Enclosed single pole relay with 12V, 185 ohm coil and 3A @ 250 volt AC switching capacity (RS 348-908)
D1-4 1N4004

Resistors

R1 100k
R2, 3, 4, 5 — 47R
R6, 7, 8, 9 — 100R
(All $\frac{1}{2}$ watt, 5% unless otherwise stated.)

General Hardware

2 handles—RS type 509-917
4 0.1in. x 24 way gold-plated edge connectors (RS type 466-545)
1 x 1SEP Horizontal rail SR.RL 169 (ITT E-PAK 46) (to be cut into 8 x 55mm lengths)
or 8 x 55mm lengths of 10 x 12mm aluminium bar
4 x foam rubber 'spacing pads' to suit card areas, $\frac{1}{4}$ in. thick
20 x 12mm CSK Pozidrive screws
20 x $\frac{1}{4}$ in. brass spacers M4 or 4BA to mount slide pots
10 x Slider Bezels (RS type 543-406)
1 x relay mounting plate (e.g. RS type 349-119 if RS continental series relays are used)
7 x 5 amp barrier strips (RS 423-497)
14 x 5 amp barrier blades (RS 423-504)
1 x 20 way Cannon chassis plug (RS type 466-040)
1 x 20 way Cannon cable socket (RS type 466-084)
1 x Cable shell to suit socket (RS type 466-129)
Solder tags, rubber sleeving, single and balanced (twin) screened cable, 7/0.2, 16/0.2 and 32/0.2 wire, 14 swg or 2.5mm square solid copper wire.

Turntables— See text
Cartridges— Stanton 500AL, 500E or 680EL (Wilmex Ltd.) or Shure SC35
Turntable Lamps— Maplin type WF22Y (See text) (Wilmex Ltd., Compton House, 35 High Street, New Malden, Surrey KT3 4DE)

THE POWER SUPPLY

The discotheque desk is connected via an umbilical cord to a remote power supply, which can be rack mounted with other equipment. In this manner, design compromises are avoided to a great extent.

With reference to Fig. 16, the mains supply is applied to an IEC connector which has an integral RFI filter. S1 is a heavy duty switch capable of handling the large surge currents which occur at switch on. S2 is an optional lockswitch which is intended to prevent unauthorised operation of the equipment. This switch is not suited to handling the current surge which occurs at switch on, therefore it is always wise to turn S1 off before turning S2 on. The unit is then turned on by means of S1 in the normal fashion. Fuses 2-7 have been selected to protect individual power supplies. If the stated fuse values or their close equivalents are used, then there will be discrimination between FS1 and the remaining fuses. Thus if FS3 blows, all other circuits will continue to function. Neons LP1-7 indicate fuse failures. The transient suppressor (VDR) and the snubber (C1, R1) ensure that high voltage transients appearing on the mains supply are rendered harmless.

REGULATOR PROTECTION

IC1-7 are protected against short circuits and shutdown if the supply current or device dissipation becomes excessive. The regulators are mounted on large heatsinks to ensure a low operating temperature; this in turn ensures longevity. RLA1-2 and the Zeners provide overvoltage protection by disconnecting the supply rails.

47V SUPPLY

The 47V supply is Zener regulated and can supply some 5mA which will suit the majority of capacitor microphones. In some circumstances, C14 may require uprating, depending on the degree of ripple rejection in the head amplifier. Some capacitor microphones operate only on lower supply voltages, e.g. 9V. In this case, T3, R6, R7 and D10 must be changed and advice should be sought from the microphone manufacturer on current and ripple rejection requirements. If dynamic microphones are to be used exclusively, then this supply can, of course, be omitted, along with FS7 and LP6.

The monitor I.e.d.s indicate any supply failures which do not cause fuse failure, for instance, operation of RLA1 or regulator shut-down in the event of a short circuit. S3 controls the earthing arrangements. In any audio system using more than one mains powered unit, the mains earth must be connected at only one point, otherwise a hum loop will be formed. (This does not apply to units connected by audio transformers, e.g. those using balanced lines.) For safety however, all exposed metalwork must be earthed.

An elegant solution is to separate chassis (safety) and OV (signal) earths. The chassis earth is always connected directly to the mains earth whilst the OV connections also go to this point, but via a small resistor, which provides 'ground-lift'. The value of this resistor is selected so as to limit the magnitude of the current flowing in the earth loop(s), hence minimising hum. A suitable value is 47R (R2 in Fig. 16), but a higher value may be necessary if the groundlift resistors in other items of equipment can appear in parallel. It is a good

idea to connect the OV rail on one item of equipment directly to the mains earth, and S3 provides this option on the power supply. If possible, all equipment to be used in conjunction with the desk should be modified so as to incorporate a groundlift resistor between chassis and OV. In this way, the dangerous practice of removing earth wires from mains plugs in a desperate attempt to banish an annoying buzz is made redundant.

CONSTRUCTIONAL DETAILS

C5, 6 and 11 must be close wired to their respective regulators; they are most conveniently mounted on a tagstrip. Tubular capacitors are specified because standard p.c.b. types are readily broken when they are wired in this fashion. The resistors associated with each l.e.d. together with the components associated with the 47V supply are mounted on a p.c.b. IC1 and 2 are readily mounted directly onto a heatsink, but IC3 has a TO3 style package and must be mounted on a bracket. This in turn is bolted to the heatsink. The bracket should be aluminium and could be either a slab bent at right angles or better, a short section of 35 x 35mm angle of reasonable thickness, so as to minimise the thermal resistance between the device and the main heatsink. All surfaces should be smeared with heatsink compound for the same reason.

All three regulators must be insulated from their respective heatsinks with mica washers; be sure to deburr the mounting holes and to clean and sand the area thoroughly so that the mica is not punctured or subsequently weakened by sharp projections.

Before testing the completed unit, remove all the fuses; then replace one fuse at a time and test each supply individually. Check especially that each voltage appears at the appropriate pins on the output socket.

POWERING-UP THE DESK

Disconnect all d.c. supply connections at barrier strip No. 7 and connect up the power supply via the umbilical cord. Remove the fuses again and turn on, then power up each supply individually, as before, and check that all voltages appear at the appropriate points on barrier strips 3 and 7. Then turn off the power supply, replace the barrier strip connections. Plug in all the cards and turn on the power supply. Check the monitor l.e.d.s in case of short circuits on the supply rails. Connect an amplifier to the mono output socket and test all the functions.

The completed desk should be soak tested for a couple of days if possible so that faulty components are weeded out before the equipment passes into service, where failures are inexcusable.

Before taking it on the road, strap down the cards to the front panel and tension them towards the edge connector by means of two rubber bands. However firmly they may fit, it is possible that they will shake loose in transit unless made captive in this manner.

DISCS, TURNTABLES AND CARTRIDGES

Apart from being easy to operate, versatile, reliable and robust, the desk is capable of providing sound quality equal to up-market Hi-Fi systems. In order to make use of this, a high power sound system which need not be run into clipping at discotheque sound pressure levels is essential. Next, good loudspeakers, then good discs, then good acoustics, turntables, equalisation, and a host of other requirements. But the first three items on the list are certainly the most crucial. The quality of disc pressings warrants particular attention. Using the prototype desk in conjunction with high

quality power amplifiers, a horn-loaded speaker stack and a good record pressing provides sound that is to all intents and purposes indistinguishable from a live performance under appropriate conditions. To make the most of this system then, it's essential to seek out well pressed discs. It is said that some 60% of records are faulty or poorly pressed and you may need to return a record several times before you receive a good pressing. A few records are poorly recorded; in particular, out of balance tonal quality can result from incorrect compensation for high SPL and lengthy all-night mix-down sessions. Alternative mixes may be sought, or an equalised tape recording of the disc may need to be made. 12in discs are invariably well pressed and very lifelike. Surprisingly 'Once a good pressing—always a good pressing'—a well pressed disc will retain its sparkle for a long time. With all this in mind, the disc remains far superior to most taped material unless you have access to master tapes; a well pressed disc has an ability to 'jump out of the speaker' with alarming realism. A good record pressing can also be played at higher levels than a tape without inducing nausea; presumably because distortion is either lower or more amenable to the ear.

CHOICE

Whether used live for discotheques and broadcasting, or for recording, the cartridges must withstand slip and back cueing. In mobile applications they must also withstand severe shocks. It is not unknown for cartridges to fall out of arms in transit. Under no circumstances should ordinary magnetic cartridges intended for domestic hi-fi systems be used; the frequent necessity for high tracking weights (> 3 grams) and back cueing in particular will rapidly degrade the performance of such a cartridge, or even worse, cause sudden failure. Readily available cartridges which are designed to withstand the rough handling inherent in broadcast and discotheque applications are manufactured by Stanton and Shure. The Stanton 500 series cartridges have found great favour on the American discotheque scene and are also widely used by the IBA in this country. The Shure SC35 on the other hand is favoured by the BBC. The choice of cartridge mainly boils down to what sort of colouration you like, the Stanton 500AL for instance having a response peak around 25Hz which gives it a characteristic sound. Turntables may be budget domestic types with integrated arms such as the Garrard SP25 used in the prototype. Ideally, these should have idler wheel drive for rapid starting but belt driven turntables can prove satisfactory in practice and also exhibit lower rumble. The desk deserves the best turntable you can afford however, and if possible, a professional broadcast model should be sought, such as classic models from Technics, Gates or Russco. Arms should be chosen for robustness over any other consideration.

Record bounce causes headaches for many operators. Short of hiring a concrete mixer and laying your own floor, there is a simple way around the problem provided you are willing to flex your muscles—the desk should be mounted on the heaviest possible stand. The prototype resides on a stand weighing some 100kg (inclusive) and floor vibrations with a peak-to-peak amplitude of around ½in are necessary before record bounce occurs. Breeze blocks, paving slabs or tractor weights can be borrowed and tied to the stand under such severe conditions. It is also useful to place the stand in a corner, where it will receive most support, and to keep the audience back. Under these conditions, a tracking weight of 4½ grams will usually be quite adequate, as opposed to 7 or 8 grams which may be required without a heavyweight stand.

COMPONENTS

POWER SUPPLY

Resistor

R1	100 0.5W
R2	47 0.5W
R3	680 1W
R4	470 1W
R5	470 1W
R6	2k2 3W
R7	1k 5W
R8	245V transient suppressor (RS 238-457)
R9	470 1W

Capacitors

C1	100n, 100V polypropylene
C2	100n 250V tubular polyester
C3-C4	33,000µ, 40V can elect.
C5-C6	100n tubular polyester 160V
C7-C8	470n tubular polyester 160V
C9	100n 250V tubular polyester
C10	33,000µ, 40V can elect.
C11	1µ tubular polyester 160V
C12	470n tubular polyester 160V
C13	100n tubular polyester 250V
C14	100µ axial elect. 100V

Semiconductors

IC1	7815-1.2A plastic regulator
IC2	7915-1.2A plastic regulator
IC3	78H12-5A metal can regulator

D1-D2	1N5355B (18V, 5W)
D3	BZX-61C-47V (47V, 1.3W)
D4-D7	Red panel l.e.d.s (RS 576-327)
D8	Yellow panel l.e.d. (RS 576-355)
REC 1	6A Bridge (100V ^{VRRM} 180A IFSM)
REC 2	10A Bridge (100V ^{VRRM} 180A IFSM)
D9, D10	1N5401
REC 3	2A Bridge (200V ^{VRRM})

Miscellaneous

SK1	IEC socket with integral r.f. filter, 2A type
SK2	20 way Cannon chassis socket—(RS 466-084) 20 Way Cannon cable plug and shall (RS 466-040) (RS 466-129)
S1	S.p.s.t. toggle 15A
S2	D.p.s.t. toggle 3A
FS1	5A 20mm quickblow
FS2-FS4	600mA 20mm quickblow
FS5-FS6	200mA 20mm antisurge
FS7	100mA 20mm quickblow
(Fuseholders all 20mm flush bayonet release types)	
LP1-LP7	Panel neons
RLA-RLB	12V, 110 ohm, coil, 10A d.p.c.o (RS 348-756) Relay sockets (RS 401-706)
T1	15-0-15V, 1.6A
T2	15V, 4A
T3	40V, 150mA
Heatsinks	1.5°C/Watt (2 off)

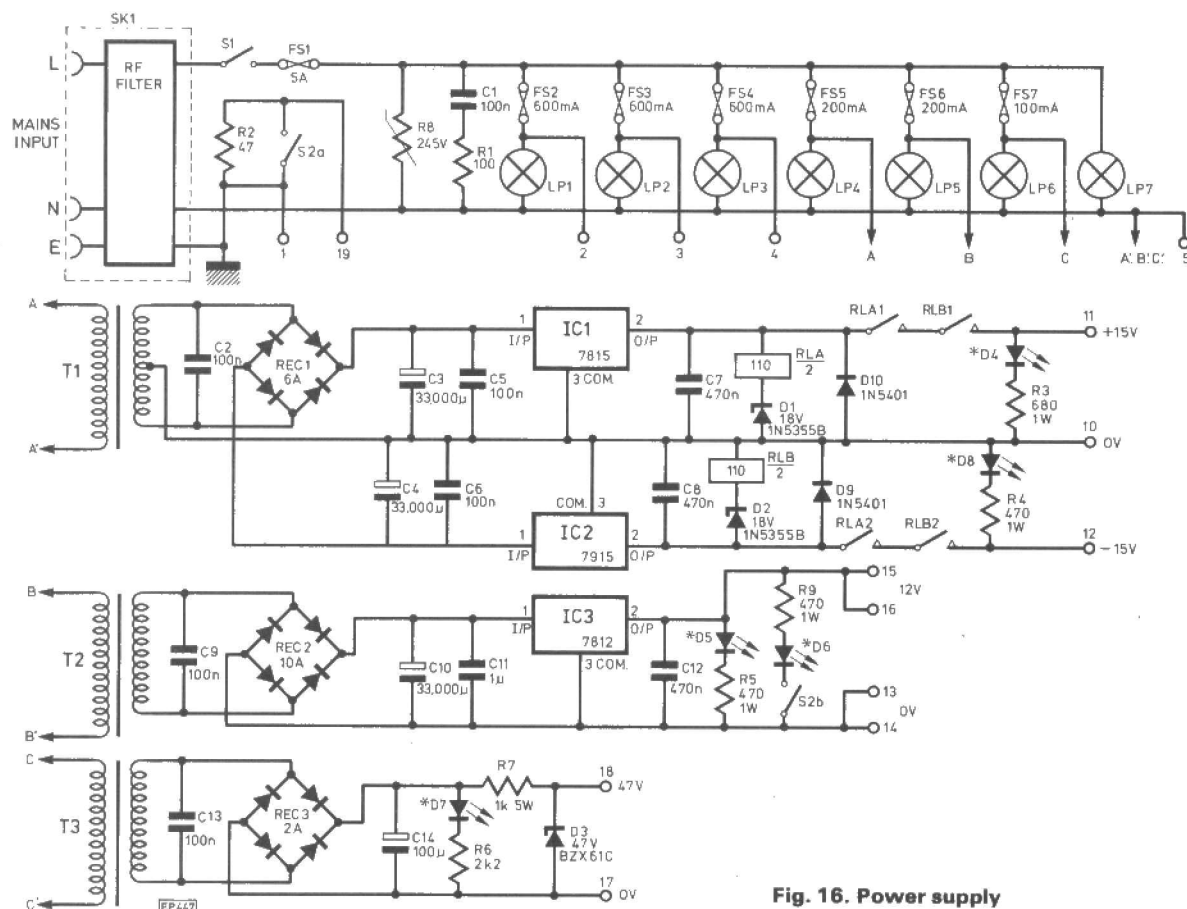


Fig. 16. Power supply

Fig. 17. Cartridge wiring to one turntable. Note that the 0V connection DLA is not connected to the cable screen or turntable chassis at any point. The screen is connected to chassis earth at the barrier strip only

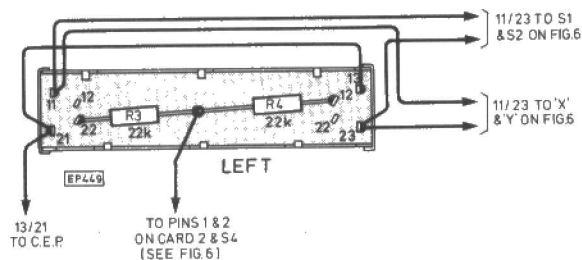
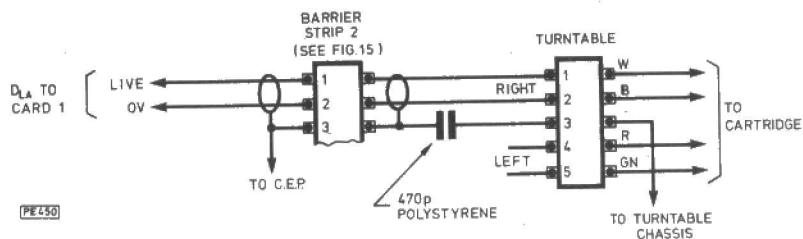
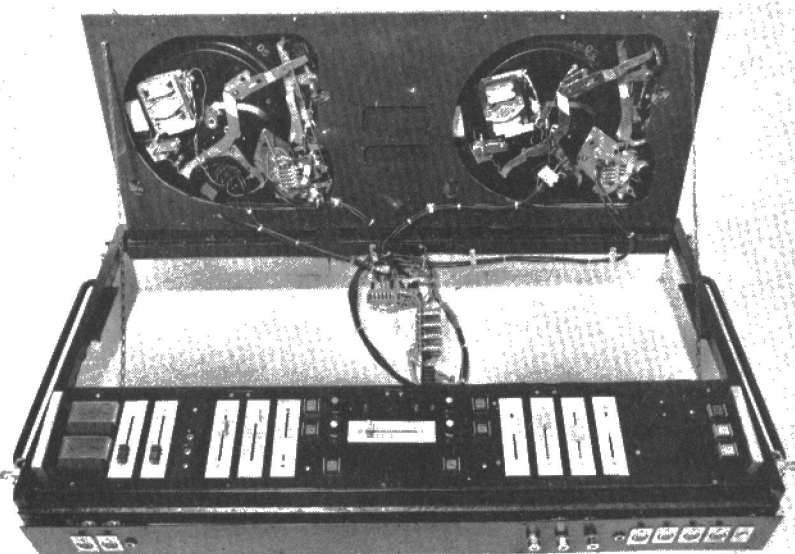
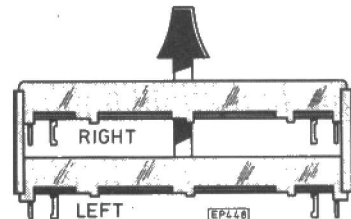
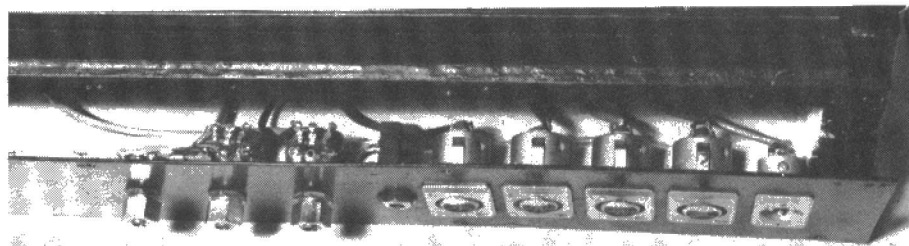
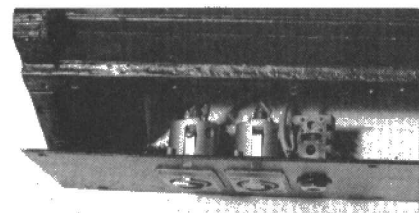
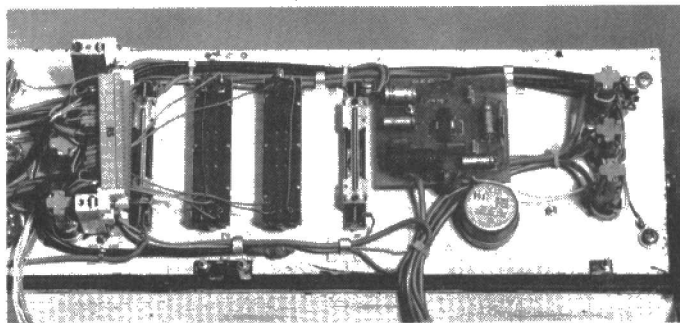
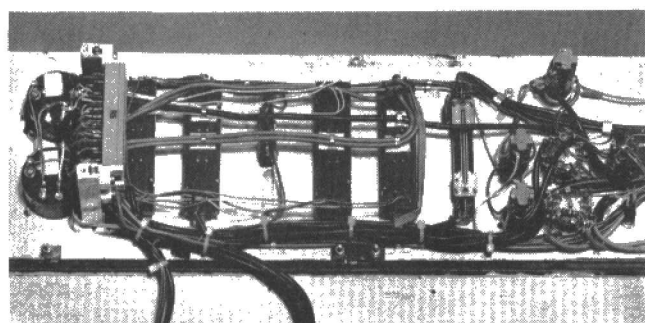
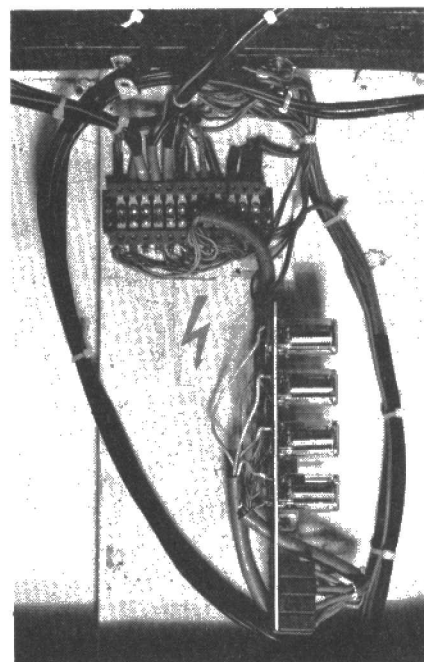


Fig. 18 (left). Showing underside of crossfader for left channel. The wiring to the right is identical but the connections from tags 11/23 to X and Y are omitted



Showing interiors of turntable compartment (above); and (right) detail of relays and snubbers (see Fig. 15)



THIS program produces a graph of a function (expressible in the form $y=f(x)$ using standard BASIC notation) for a range of x values. It is self-scaling once it has been given the range of x , finding the lowest and highest y values. It also draws the lines $x=0$, and $y=0$, when they fall within the x or y values.

METHOD

On the UK101, reasonable resolution can be obtained using the graphics characters. The screen is 46 by 16 chars, but the graphics include 8 horizontal bars.

These bars can increase the resolution to 46 by 128 allowing a reasonable curve to be drawn.

The first problem encountered was how to change the function of x every time the program is run. The simplest answer is this:

```
100 PRINT " Please type : "
110 PRINT " 5000 Y=f(X) "
120 PRINT " GOTO 1234 "
130 STOP
1234 program
```

This is not ideal. The best answer is to make the program alter itself. Microsoft BASIC is memory efficient for the reason that the commands are abbreviated by the use of tokens.

What does a Basic line look like in memory? Consider this line:

10 Y=X

If the relevant section of memory is examined, the line is stored as follows:

14 3 10 0 89 171 88 0

The "14 3" in the first and second byte means the next BASIC line is stored at memory location $14 + 3 \times 256 (=782$ decimal). The "10 0" in the next two bytes indicates that this is BASIC line number $10 + 0 \times 256 (=10$ decimal). 89 is the ASCII code for Y, and 88 for X. So somehow 171 means "=", and 0 means the end of the line.

So far:

14 3 10 0 89 171 88 0
782 line 10 Y = X END of line

A full list of tokens is given in Table 2 only those underlined are useful for the function of x .

TABLE 2: Tokens. Those underlined are used

128 END	151 PRINT	174 INT
129 FOR	152 CONT	175 ABS
130 NEXT	153 LIST	176 USR
131 DATA	154 CLEAR	177 FRE
132 INPUT	155 NEW	178 POS
133 DIM	156 TAB(	179 SQR
134 READ	157 TO	180 RND
135 LET	158 FN	181 LOG
136 GOTO	159 SPC(	182 EXP
137 RUN	160 THEN	183 COS
138 IF	161 NOT	184 SIN
139 RESTORE	162 STEP	185 TAN
140 GOSUB	163 +	186 ATN
141 RETURN	164 -	187 PEEK
142 REM	165 *	188 LEN
143 STOP	166 /	189 STR\$
144 ON	167 ↑	190 VAL
145 NULL	168 AND	191 ASC
146 WAIT	169 OR	192 CHR\$
147 LOAD	170 =	193 LEFT\$
148 SAVE	171 >	194 RIGHT\$
149 DEF	172 <	195 MID\$
150 POKE	173 SGN	197 to 211 BASIC error codes

Thus if we input the function of x , we can find the suitable line in memory and poke into it the function. The line which we look for is line 5000:

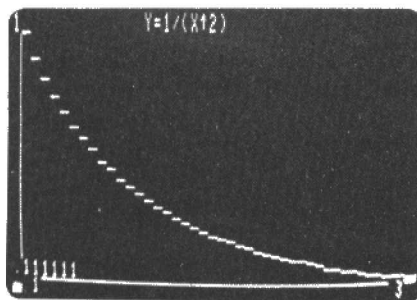
5000 ## ## ## ## ## ## ## ## ## etc.

The ## symbols are looked for in memory. When they are found the function $y=f(x)$ is poked in (the function *must* be in standard BASIC notation). The most convenient way to end a line is to make it a multi-line statement, so the colon and REM are both POKED in at the end of the line. We now have the function of our graph in the form:

5000 $y=f(x)$: REM ## ## ## ## ## etc.
5010 RETURN

Values of the range of x are then inputted, and the highest and lowest values of y are found for scaling purposes. The graph can then be plotted using the graphic characters.

SOFTWARE IDEAL FOR MATHEMATICS DEMONSTRATION.

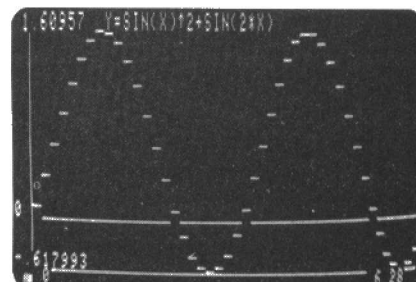


Left: Graph of $y = 1/x^2$. Note that the function must be keyed into the computer as if a BASIC statement in itself.

Right: A more complex, cyclic function. The Graph Plotter is self-scaling.

Some suggested graphs

- 1) $Y=ABS(X)$ for $x=-1$ to 1
- 2) $Y=-1 \star ABS(X)$ for $X=-1$ to 1
- 3) $Y=SIN(X) \uparrow 2 + SIN(2 \star X)$ for $X=0$ to $2 \star \pi$
- 4) $Y=1 \div (X \uparrow 2)$ for $x=1$ to 3



OK
LIST

```

10 REM *****
20 REM **** GRAPH PLOT ****
30 REM **** ===== ****
40 REM ****
50 REM **** by T.Walsh ****
60 REM **** for a BK ****
70 REM **** Compukit UK101****
80 REM *****
100 FORA=1TO16:PRINT:NEXT
110 PRINT" GRAPH PLOT"
120 PRINT" ====="
130 PRINT" by T.Walsh"
140 PRINT:PRINT
150 INPUT" Type graph in form Y=f(X)";A$
160 IFLEN(A$)>37THEN150
170 FORA=2800TO3100
180 IFPEEK(A)=35ANDPEEK(A+1)=35THEN210
190 NEXT
200 PRINT" Program error":STOP
210 Q=LEN(A$):LP=A
220 A$=RIGHT$(A$,Q-2)
230 W=0
240 POKELP,89:POKELP+1,171
250 FORA=1TOLEN(A$)
260 W=W+1
270 D$=MID$(A$,A,1)
280 IFASC(D$)>47ANDASC(D$)<58THEN500
290 IFD$="X"ORD$="{"THEN500
300 IFD$=")"THEN500
310 IFD$=" "ORD$=","THEN500
320 IFD$="+ "THENZ=163:GOTO510
330 IFD$="- "THENZ=164:GOTO510
340 IFD$="*"THENZ=165:GOTO510
350 IFD$="/"THENZ=166:GOTO510
360 IFD$="^"THENZ=167:GOTO510
370 D$=MID$(A$,A,3)
380 IFD$="SGN"THENZ=173:GOTO520
390 IFD$="INT"THENZ=174:GOTO520
400 IFD$="ABS"THENZ=175:GOTO520
410 IFD$="SQ"THENZ=179:GOTO520
420 IFD$="RND"THENZ=180:GOTO520
430 IFD$="LOG"THENZ=181:GOTO520
440 IFD$="EXP"THENZ=182:GOTO520
450 IFD$="COS"THENZ=183:GOTO520
460 IFD$="SIN"THENZ=184:GOTO520
470 IFD$="TAN"THENZ=185:GOTO520
480 IFD$="ATN"THENZ=186:GOTO520
490 PRINT"Error in function":GOTO880
500 POKELP+W+1,ASC(D$):GOTO530
510 POKELP+W+1,Z:GOTO530
520 POKELP+W+1,Z:A=A+2
530 NEXT:POKELP+W+2,58
540 POKELP+W+3,142
550 F$="Y="+A$
560 PRINT:PRINT" Enter the range of x (low";
570 INPUT" then high)";LO,HI:PRINT:PRINT
580 IFLO>HITHEN560
590 X=LO:GOSUB5000
600 YH=Y:YL=Y
610 FORX=LOTOHISTEP(HI-LO)/46
620 GOSUB5000
630 IFY>YHTHENYH=Y
640 IFY<YLTHENYL=Y
650 NEXT
660 FORA=1TO16:PRINT:NEXT
670 FORA=1TO15
680 POKE53261+64*(A-1),143
690 NEXT
700 FORA=54222TO54285
710 POKEA,135:NEXT
720 S=(HI-LO)/46
730 IFHI>0ANDLO<0THEN2000
740 IFYH>0ANDYL<0THEN3000
750 FORB=1TO46:X=(B-1)*S+LO:GOSUB5000
760 D=((Y-YL)/(YH-YL))*14+1
770 X=B:Y=D+1:GOSUB1000:NEXT
780 A$=F$
790 FORA=1TOLEN(A$)
800 POKE53279+A-LEN(A$)/2,ASC(MID$(A$,A,1))
810 NEXT
820 A=54221:A$=STR$(LO):GOSUB6000
830 A$=STR$(YH):A=53259:GOSUB6000
840 A$=STR$(YL):A=54155:GOSUB6000

```

```

850 A$=STR$(HI):A=54264-LEN(A$):GOSUB6000
860 POKE530,1:POKE57088,0
870 IFPEEK(57088)=254THEN860
880 POKE530,0:FORA=1TO39:POKELP+A-1,35:NEXT
890 RUN
1000 Z=54285:S1=INT((Y-INT(Y))*7+.5)
1010 POKEZ-INT(Y)*64+X,128+S1:RETURN
2000 A=53262+15*64+(ABS(LO)*46/(HI-LO))
2010 POKEA,48
2020 FORB=0TO15
2030 POKEA-(B+1)*64,143
2040 NEXT:GOTO740
3000 A=54220
3010 A=A-INT(ABS(YL)*15/(YH-YL)+.5)*64
3020 POKEA,48
3030 A=A+2
3040 FORB=0TO45
3050 IFPEEK(A+B)=143THENPOKEA+B,208:GOTO3070
3060 POKEA+B,128
3070 NEXT:GOTO750
5000 #####
5010 RETURN
6000 FORB=1TOLEN(A$)
6010 POKEA+B,ASC(MID$(A$,B,1))
6020 NEXT:RETURN

```

OK

LINES

100 to 160	Inputs function
170 to 540	Finds line 5000 in memory and pokes the function of x in
550 to 650	Inputs the low and high values of x and from these calculates the maximum and minimum y values
570 to 850	Plots graph
860 to 890	Waits for any key to be pressed and then returns line 5000 to its original format
1000 to 1050	Plots the horizontal bar
2000 to 2040	Plots the line X=0 [if applicable]
3000 to 3070	Plots the line Y=0 [if applicable]
5000 to 5010	Function of graph in form Y=f(X)
6000 to 6010	Pokes the contents of A\$ into a part of the screen pointed to by the contents of A

IMPORTANT VARIABLES

HI	highest value of X
LO	lowest value of X
LP	position of line 5000 in memory
YH	highest value of Y
YL	lowest value of Y

NOTES

- 1) line 5000 should be retyped if the program is stopped halfway through
- 2) the function of X must be in standard Basic notation. Any error will mean that you will have to retype line 5000, and re-run the program.
- 3) all angles are in radians.
- 4) do not try to plot infinity [eg tan of a half of pi]

MICRO PROMPT.

The hardware and software exchange point for PE computer projects

LISTLESS SOFTWARE

A method for protecting your BASIC from being LISTed by a spy has been sent in by Mr. Mistry of Bradford.

Add line zero to your program; which might be: **O REM**—some program—for example.

Then **POKE 769, 0** in Command Mode.

Any alteration to the listing, after this, will crash the system.

For return to normal, **POKE 769, 7**

PIECES OF EIGHT

Sir — I have decoded the memory block 2000–3FFF on my UK101 in the following way, while I use the decoding for I/O and an EPROM programmer, they could be used for other things:

IC23 (74LS138) seems to decode the whole 64K into 8K blocks most of which are not used. The unused pins can just be bent out and used to decode the 8K blocks, ie. pin 14 decodes 2000–3FFF
13 decodes 4000–5FFF
12 decodes 6000–7FFF
11 decodes 8000–9FFF

remembering that 1K EPROM, for example, would appear more than once in the 8K block selected.

To decode 2000 to 3FF into 8 × 1K blocks I soldered another 74LS138 onto IC22.

PIN 4 connects to Pin 14 (Y1) of IC23

7 (Y7) decodes 2000–23FF

9 (Y6) decodes 2400–27FF

10 (Y5) decodes 2800–2BFF

11 (Y4) decodes 2C00–2FFF

12 (Y3) decodes 3000–33FF

13 (Y2) decodes 3400–37FF

14 (Y1) decodes 3800–3BFF

15 (Y0) decodes 3C00–3FFF

I have transferred the Compukit Screen Edit tape to EPROM which runs at 2000–23FF, but does anyone know how to transfer the extended monitor?

J. Walton,
Newton,
Derbyshire.

It should be emphasised that material presented in Prompt has not necessarily been proven by us. Neither can compatibility with all generations of the computer equipment to which it relates be guaranteed.

Software and hardware designs submitted should be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

MADE FOR EACH OTHER

Sir—The Transam Triton microcomputer's on board memory ends at address 1FFF. This makes interfacing to Dr. Berk's EPROM programmer extremely simple, provided that it is the only off board memory in use. A0 to A10 from the EPROM board are connected to the corresponding address lines from the Triton expansion socket and the board enable is connected to the Triton A13, which only goes high for addresses over 1FFF Hex. A10 goes high every time an address containing X4XX is accessed (X = don't care), but the board is not enabled until A13 is active, therefore A10 only becomes effective when we reach 2400, which is just what we want and locates the EPROM block directly following the RAM block. This allows both RAM and EPROM to be accessed under program control, and the Triton's monitor will accurately locate the end of the new RAM with its memory check procedure, which is needed for the correct operation of the basic interpreter.

Obviously A13 and A10 will also become active for addresses further up the map, but if the EPROM board is the only off board memory expansion, then higher addresses should never be accessed except under error conditions, in which case the RAM might be interfered with, but then, that would probably happen anyway under error conditions. Any other memory expansion would no doubt use the Triton motherboard which changes the problem completely.

Triton Socket	EPROM Board
MEMW	R/W
Ground	0 volts
Five volts not available from socket—wire to regulator	
A13	Pin 6, IC10 (enable)
A0	A0
—	—
A10	A10
D0	D0
—	—
D7	D7

One change must be made to the board, due to the fact that we are using a positive going address line rather than a zero going decode line for the ENABLE. We therefore leave out the gate 1C8A which merely inverts the ENABLE, and connect the Triton's A13 to pin 6 of IC10. This is easily done as the track on the top of the EPROM board nearest the l.e.d. is the track which connects the two. Cut the track or simply leave out the through board pin nearest the l.e.d., and connect the A13 signal to this track. Both pins 1 and 2 of 1C8 should then be connected via link L10 to +5 volts as it is

bad practice to leave t.t.l. inputs floating.

The redundant gate (IC8A) can be put to use to give a very useful added facility.

As we are allowing the computer to select between the RAM and the EPROM by the use of the address line A10 rather than using a switch and doing it manually, we are getting the best use of the extra memory available. However, we are unable to try routines in RAM before burning them into EPROM as the computer sees them as two separate blocks of memory and internal calls or jumps will not work in both blocks (not with 8080 direct addressing). This can be overcome by using the redundant gate to invert A10 and selecting either the inverted A10 or the non-inverted A10 with a single pole changeover switch (Fig. 1). This effectively swaps the positions of the RAM and EPROM as far as the computer is concerned. Therefore a program can be developed and debugged in RAM at addresses between 2400 (Hex) and 27FF (Hex) which is normally the EPROM's address, then it can be burnt in and run in EPROM after the switch is returned to normal. All this without losing the advantage of simultaneous use of both blocks of memory.

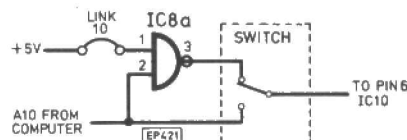


Fig. 1. Address inversion switch

Note that this is not suitable where a decode line has been used for interfacing, as the gate IC8A is already in use.

Iolo Davidson,
Hawling,
Gloucestershire

PREMIER SOFTWARE FOR UK101

Two software cassettes are available from Premier Publications of 12 Kingscote Road, Addiscombe, Surrey.

The first is called "Strategy Games Pack", and is Superboard compatible. It contains three well presented and compulsive games: Nine-In-A-Line, Square Solitaire, and Executive Jigsaw. The start of the tape loads in some utility machine code software to support these games.

The second tape is called "Utilities Pack" and comprises a range of subroutines which can be called up by the user's own main program, after which, any unused utility routines are removed.

A subroutine is included for screen location identification via a grid system. Another routine provides a precision random number generator with more linear distribution. There is also a "read data" routine which overcomes the need for a FOR-NEXT loop to find a particular datum. When GOSUB 30 is called, the piece of data is returned as Z8.

There is a kind of direct telewriting subroutine, a routine for driving the cursor around the screen, and much more useful software.

Premier publications: ☎ 01-656 6156.

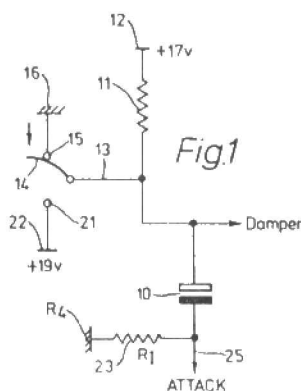
PATENTS REVIEW...

Copies of Patents can be obtained from:
the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price £1.25 each.

JOANNA

British Patent 1 559 371, dating back to May 1975, has been granted to Alan Boothman and covers the "PE Joanna". The actual patent title is however rather more formal: "Touch sensitive electronic key operated circuitry".

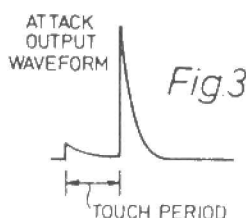
As the inventor points out in the patent introduction, past electronic keyboard instruments have suffered from the disadvantage that there is a lack of touch sensitivity i.e. the quality of a note is not affected by the manner in which the controlling key is struck. The PE Joanna offers a fair degree of touch sensitivity and Figure 1 shows the basic circuit. Capacitor 10 of capacitance



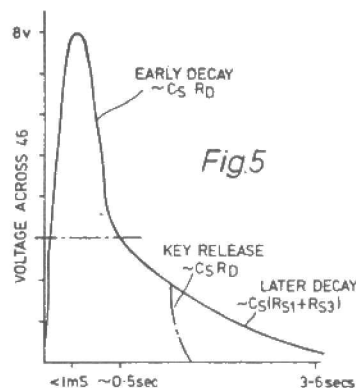
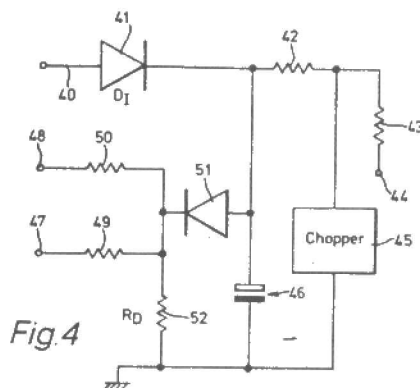
CT is connected via resistor 11 of resistance R_T to voltage rail 12 at +17 volts. The junction of resistor 11 and capacitor 10 is connected to the pole of a keyboard switch 14. This pole is biased to earth terminal 15, but finger pressure connects it to higher rail 22, at +19 volts. So when the keyboard switch is depressed the capacitor charges at rate CT/R_T and to level related to the time of depression. The other side of capacitor 10 is connected via resistor 23, of value R_1 , to earth. A line from the junction of resistor 23 and capacitor 10 delivers a variable attack pulse signal to a circuit for controlling the decay characteristic of a tone drive signal.

Figure 3 shows an idealised attack pulse output characteristic. There is a relatively insignificant initial positive excursion, a larger signal at the end of the touch period

when the capacitor is driven directly by the voltage on line 22, and decay via resistor 23. Attack level is thus proportional to the time taken to depress the key and therefore to the average speed of depression. This approximates the hammer velocity of a piano keyboard.



The attack pulse from junction 25 of Figure 1 is fed to a wave shaping circuit shown in Figure 4. The incoming pulse charges capacitor 46 to produce a curve characteristic as idealised in Figure 5. The decay period is in two parts; the first is fast (but slower than the attack pulse) and the second is relatively slow. Figure 4 also shows damper control input 48 which is connected to the junction of capacitor 10 and resistor 11 in the attack pulse circuit of Fig. 1. Damper diode 51 holds the voltage across capacitor 46 at near zero until the voltage from line 22 is applied to raise the cathode of diode 51.



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TORPEDO GAME

THIS game is designed so that a target moves across a l.e.d. display. The object of the game is to send a torpedo along a 'Torpedo display' perpendicular row of l.e.d.s to intercept the target at D12.

The target moves from the left to the right, at an adjustable speed, which is controlled by VR1. The target length is also adjustable by S3, a single pole three way switch (or a single pole centre off):

Position 1 of the switch gives a target length of 1.

Position 2 of the switch gives a target length of 2.

Position 3 of the switch gives a target length of 3.

The torpedo is triggered off by push-to-break switch S2. When it has travelled down its row of l.e.d.s, it loads the shift register (IC3) with a new code ready for the next fire instruction. Because of this, a torpedo cannot be fired while one is already in motion. If the torpedo, by the operator's skill, hits the target at the cross point of D12, everything stops with it still lit. To cancel this hold situation there is a clear switch (S1), which is a push-to-make switch.

Like the target, the torpedo also has a speed or rate control, and is preset by VR2.

Both l.e.d. sets only have one current limiting resistor each, as shown. This is because all the l.e.d.s are never on together at one time. This allows all the anodes to be wired together in each display set.

The process of making the target travel along the row is done by shifting data along two 8 bit shift registers (IC1/2) wired in series. When the clear switch is pressed data is entered into the shift registers by the parallel inputs A—H as shown. (Note: IC5-7408.)

When the clock inputs to the registers are enabled, the code stored shifts along the data lines. The rate at which the data is shifted along is determined by the SN7414 (IC4) oscillator frequency. The shift sequence is shown in the table.

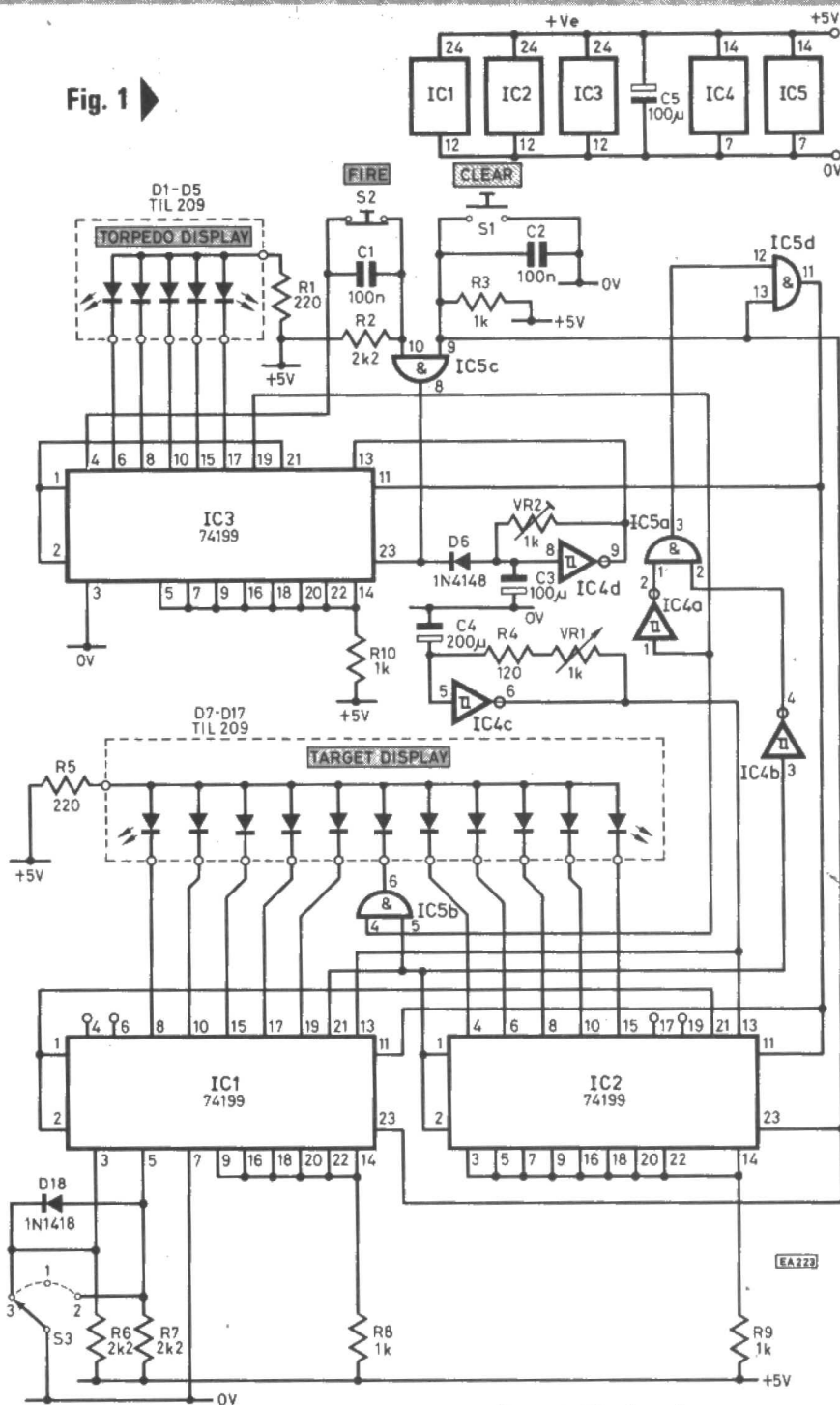
The game requires a current of 200mA at 5V.

M. Crisp,
Semington,
Wilts.



Fig. 2

Fig. 1



		Outputs Displayed															
Clock		A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
1		0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
2		1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
3		1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1
4		1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1
5		1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1
6		1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1
7		1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1
8		1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1
9		1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1
10		1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1
11		1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1

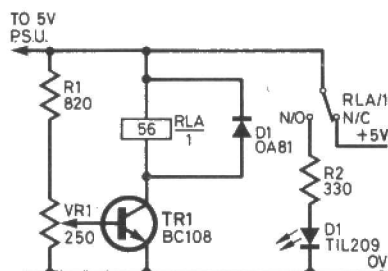
Fig. 3

THIS circuit was devised to protect TTL when running them in soak test situations from a variable stabilised power supply, and there is a possibility that someone might alter the output voltage—possibly causing a lot of damage.

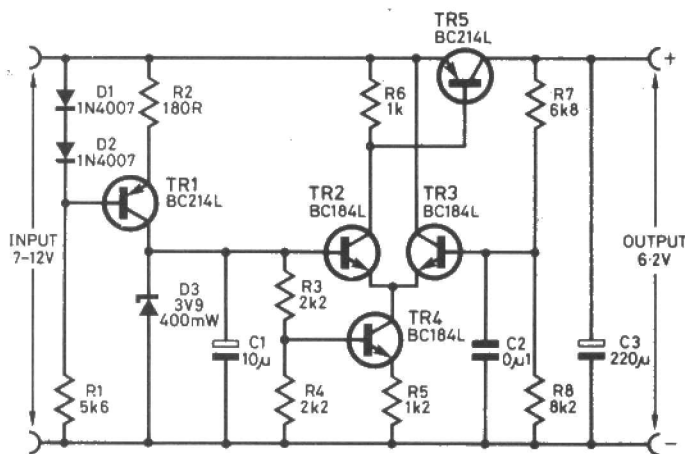
The idea is very simple, and the unit is inserted in the power lines. R1 and VR1 apply a potential to the base of TR1 such that with a nominal 5V supply, the transistor is just biased off. Should this voltage increase, TR1 switches on, opening the relay contacts, switching off the output supply, and lighting the indicator D1.

J. Piper,
Liskeard,
Cornwall.

TTL PROTECTION



EA213



EA214

THIS simple circuit was built to supply a regulated 6V to circuitry requiring around 50mA, from a 9V battery. It has better regulation than a simple Zener, and the quiescent current (about 5mA) is not so dependent upon battery voltage. It's principle advantages are a variable output voltage, set by the values of R7 and R8. A pre-set could be used if precise adjustment is required and the ability to operate with a very small regulated-to-unregulated

voltage differential. For the current stated it will operate down to a battery voltage of about 6.5V, for lower currents it is even less.

The circuit action is as follows: TR1 and associated components feed a constant current to the Zener, D1. The Zener voltage is fed to one side of a comparator consisting of TR2 and TR3, current fed by TR4. The other side of the comparator is fed by the potential divider R7 and R8

6V REGULATED

SUPPLY

from the regulated voltage, so at balance the voltage across R8 must equal the Zener voltage. The comparator controls TR5, the series regulator, to achieve this. C3 is the output decoupler, C2 prevents h.f. instability.

A. J. Flind,
Taunton,
Somerset.

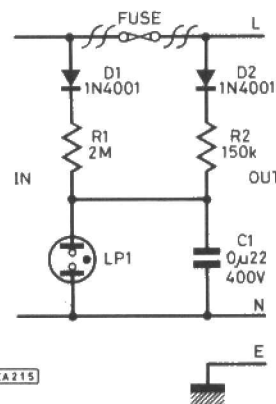
FUSE FAILURE

INDICATOR

THIS circuit was developed to indicate at a glance which fuse in my disco had blown without having to check each fuse in turn. It is useful in many applications such as on a distribution board. It can be modified to operate at lower or higher voltages or if a switch replaces the fuse one can tell if a unit is just switched off or unplugged as well e.g. a television.

With the fuse intact the neon bulb lights up with R2 dropping the mains voltage to the firing voltage of the neon. When the fuse is blown C1 charges via R1 until it reaches the neon firing voltage and then discharges through it, thus making it flash until the fuse is replaced or the appliance is unplugged.

K. A. Rochfort,
East Carleton,
Norwich.



EA215

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